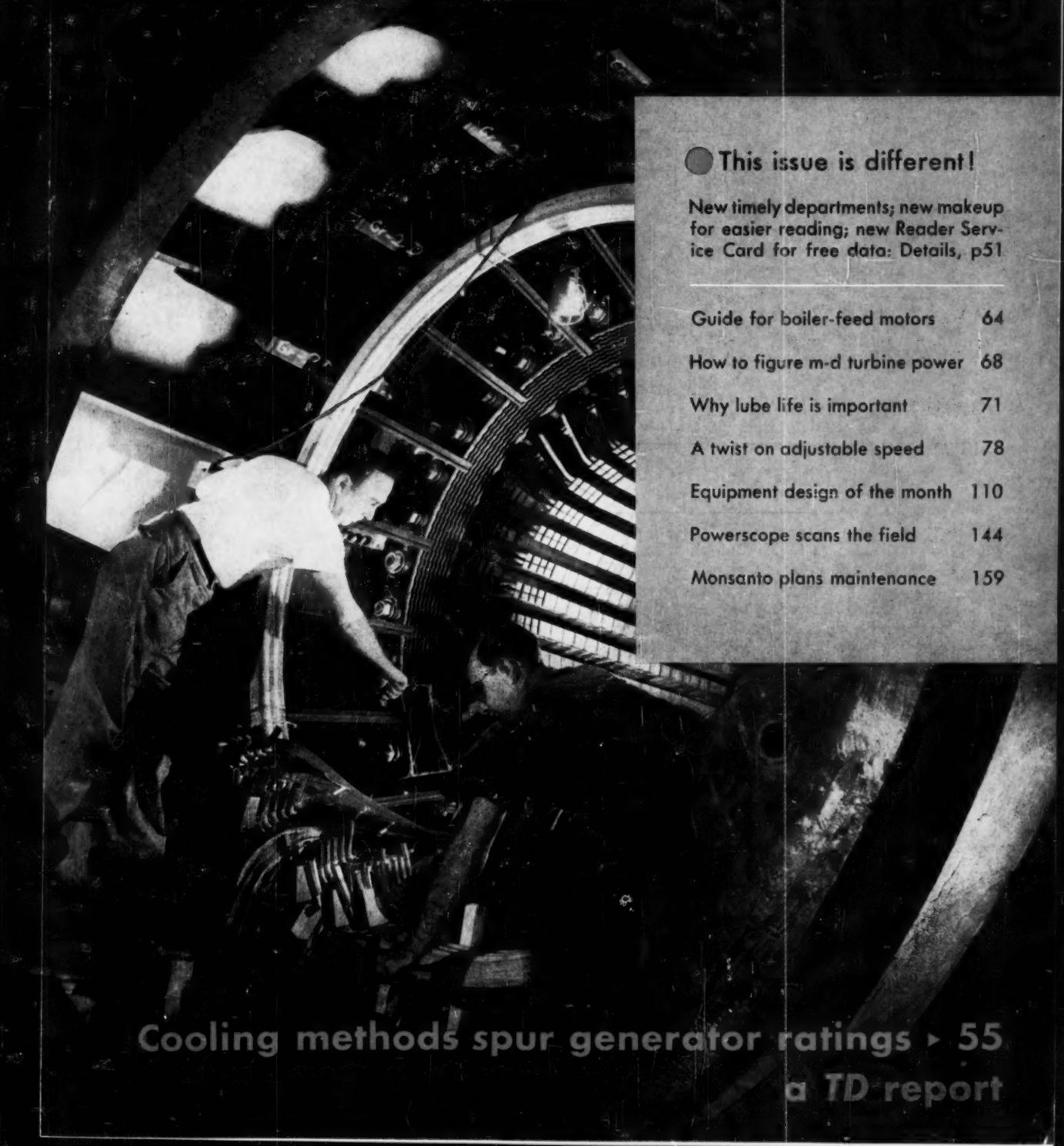
For engineers who design and manage the power and plant services

Power

JANUARY 1959
ONE DOLLAR
A McGRAW-HILL PUBLICATION



This issue is different!

New timely departments; new makeup for easier reading; new Reader Service Card for free data: Details, p51

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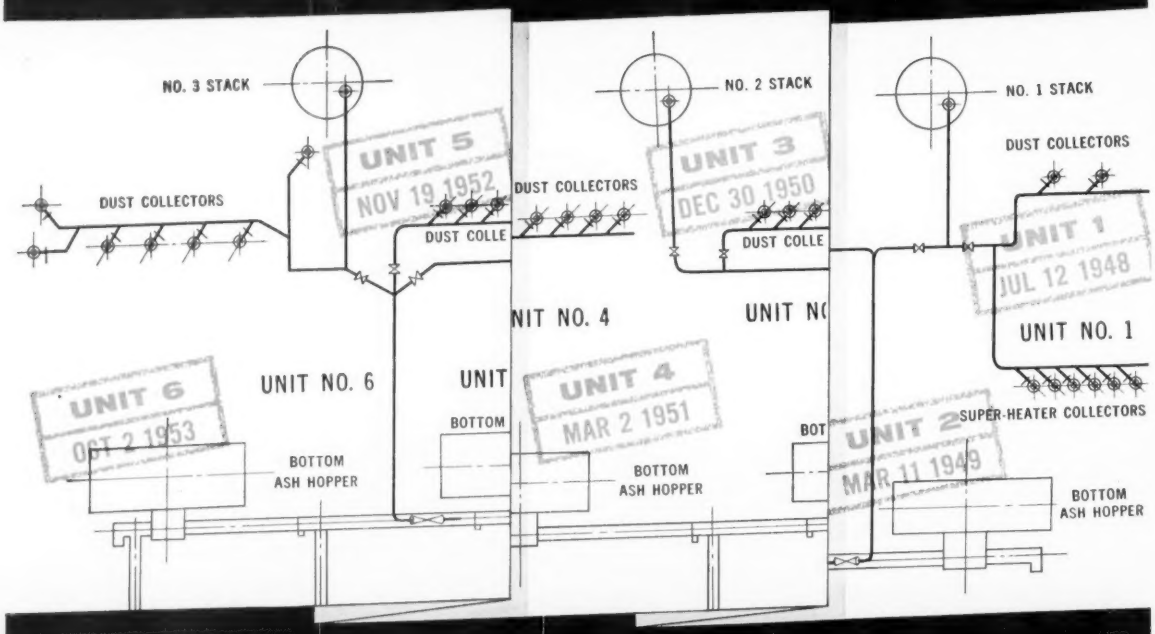
a *TD* report

PROFILE OF PLANNED PROGRESS IN ASH HANDLING:

A Unit a Year for Six Years



at the O. H. Hutchings Station, Dayton Power and Light Co.

The ultra-modern O. H. Hutchings Station of the Dayton Power and Light Company is one of the most efficient generating plants of its type in the world. It was completed on a "unit-a-year" plan to meet the increased demands of more than 250,000 consumers in Ohio's Miami Valley.

Construction of Hutchings Station began in November, 1946; the first of six 60,000 kw generators went on the line just 19 months later. On October 2, 1953, the sixth unit went on the line, bringing the station's capacity up to the planned 360,000 kilowatts.

About 182 tons of ashes are removed daily by two Allen-Sherman-Hoff hydraulic ash handling systems, each serving three steam generating units. Bottom ash is sluiced to a sump and then pumped to a fill area; fly ash is collected pneumatically and discharged to the bottom ash sluiceway, then pumped to fill.

While not unusual, the Hutchings Station installation is typical of the cooperation of A-S-H Engineers with Utility Engineers in providing planned progress in ash handling—whether it be a new station or the expansion of existing facilities.

Your local A-S-H Sales Engineer will be glad to tell you more about this cooperative problem-solving, as typified by the Hutchings Story. Ask him. If you don't know your local representative, drop us a line and we'll arrange for him to get in touch with you.

A-S-H service doesn't stop with installation. When service problems come up, we stand ready to give prompt service assistance. This is a policy worth considering when suppliers are being selected.

MATERIALS HANDLING SYSTEMS

"Hydrojet" *hydraulic*

"Hydrovac" *pneumatic*

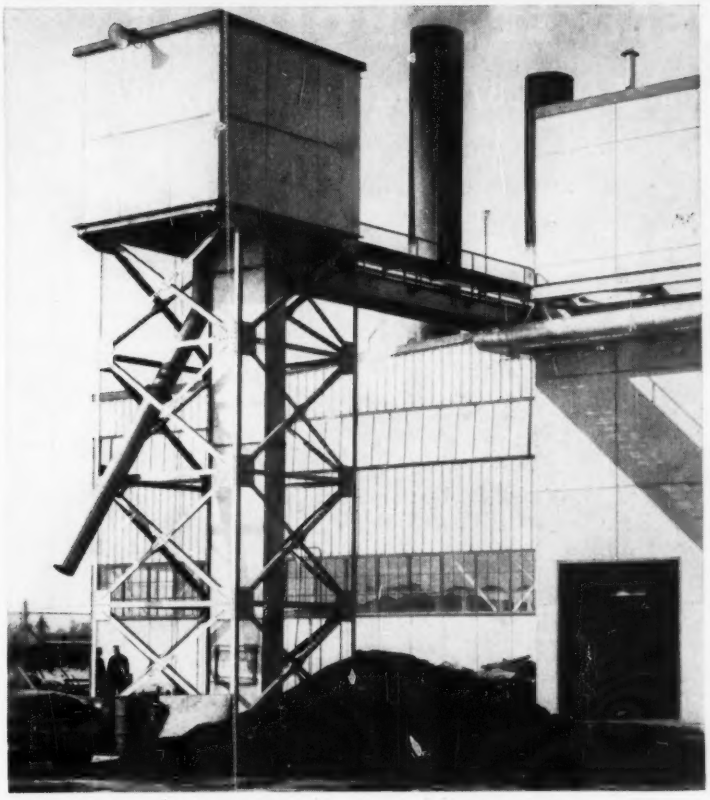
the **Allen-Sherman-Hoff** company

259 E. Lancaster Ave., Wynnewood, Pa.

Offices and representatives in principal cities

For more facts circle 201 on Reader Service Card, p 100

How Link-Belt's big-plant background boosts efficiency in small boiler houses



LINK-BELT HANDLING SYSTEM keeps powerhouse boilers supplied at Dunlop Canada Limited tire and foam rubber plants, Whitby, Ontario. Bucket elevator transfers coal from track hopper to storage or to drag chain conveyor leading into powerhouse.

Link-Belt installations are developed from industry's most extensive coal handling experience

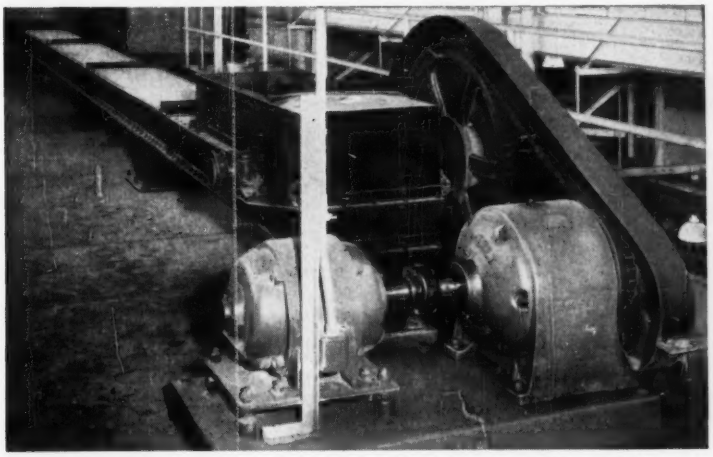
With engineering and equipment proved in some of the largest power plants in the country, as well as in smaller industrial boiler houses, Link-Belt can assure lowest possible per-ton handling costs wherever coal is a source of power . . . whether capacity is one ton or thousands of tons per hour.

Conveyors, elevators, feeders, screens, skip hoists, hoppers, chutes, gates, stackers, car unloaders and shakers, unloading towers, weigh larries and related equipment—all are available from Link-Belt—*the most complete line* in the field. And with this equipment, Link-Belt can give you a smooth functioning coal handling system that exactly matches your capacity and layout requirements. We will work with your engineers and consultants from planning through erection, if desired.

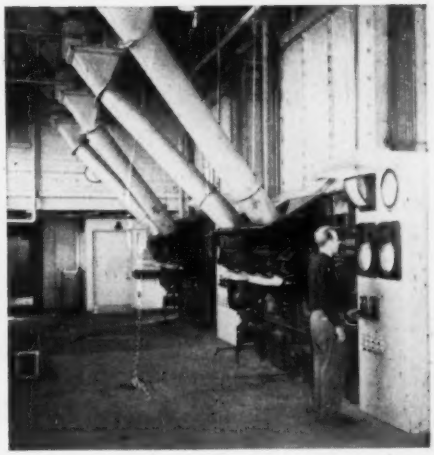
For complete details, call your nearest Link-Belt office. Or write for Book 2410. It shows the latest layouts and equipment for power plants, large and small.

LINK-BELT

COAL HANDLING EQUIPMENT



SMOOTH DISTRIBUTION — Link-Belt drag chain conveyor receives coal from bucket elevator and discharges it to Dunlop powerhouse bunkers. Conveyor's drive includes Link-Belt roller chain and helical gear speed reducer.



COAL BUNKERS are equipped with Link-Belt cast iron duplex gates which are operated by chain and wheel controls on extended shafts.

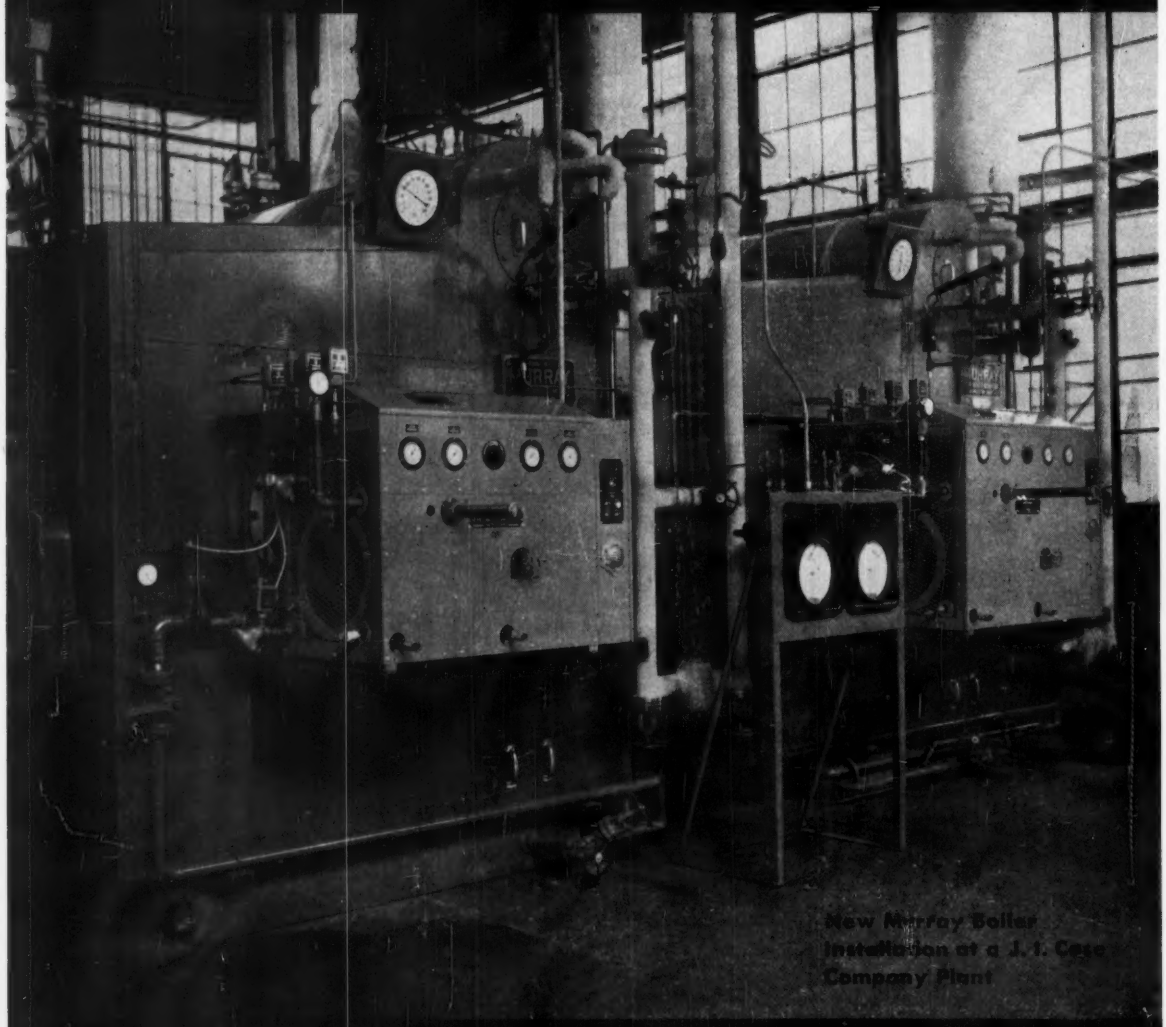
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,772

For more facts circle 204 on Reader Service Card, p 100

MURRAY *Economical, Dependable*

SHOP ASSEMBLED BOILERS

available in sizes from 5,000 LB/HR to 65,000 LB/HR



New Murray Boiler installation at a J. I. Case Company Plant

MURRAY IRON WORKS CO., BURLINGTON, IOWA

Murray Boilers Stand the Test of Time

In Power this month

JANUARY 1959 • VOL. 103 • NO. 1 • 77TH YEAR

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Print order this issue: 49,836

arctic

or tropic

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has the right valve!

Handling fluids at sub-zero temperatures or at super-heat – or any of the temperatures in between – is no problem if you install Powell valves. There is a Powell Dependable Valve to meet your most exacting flow-control requirements, no matter what the extremes of your needs.

The complete Powell line includes all types of valves in bronze, iron, steel and corrosion resistant metals and alloys, for pressures from 125 to more than 2500 pounds W.P. Consult your local distributor (there's one in most major cities) or write to:

The Wm. Powell Company • Cincinnati 22, Ohio

Dependable Valves Since 1846

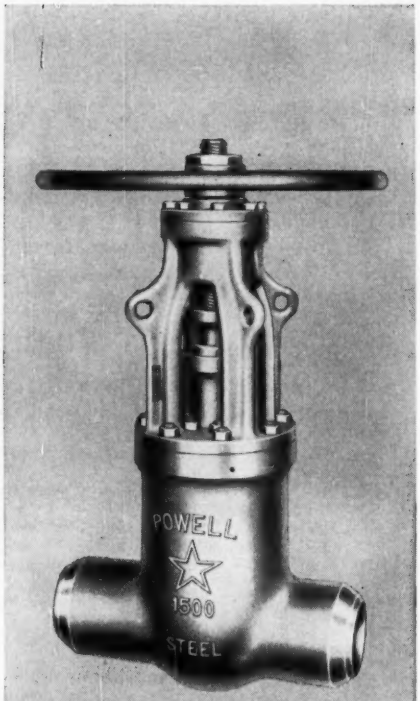

Fig. 11303 W. E.: Steel O. S. & Y. pressure seal gate valve for 1500 pounds W. P. at high temperatures. Powell pressure seal valves are available for working pressures from 600 through 2500 pounds.

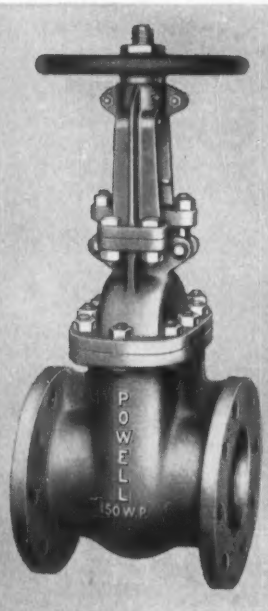

Fig. 86190: Steel union bonnet globe valve for 400 W.O.G. Designed for liquified petroleum gas service.

Fig. 2453G: Large 150 pound stainless steel O. S. & Y. gate valve for low temperature service. Can be furnished with interchangeable solid or double wedge disc.

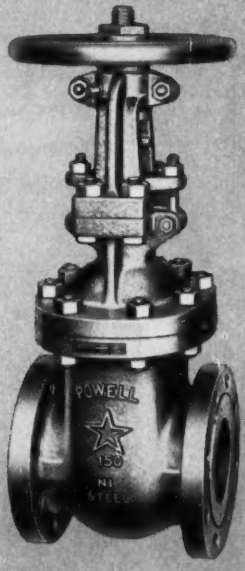

Fig. 1503 Mod.: 3½% Nickel-steel O. S. & Y. gate valve for low temperature service.

POWELL...world's largest family of valves

For more facts circle 206 on Reader Service Card, p 100

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Power • January 1959 • Vol. 103—No. 1

speaking of Power

Generator cooling has seen significant change in the past 20 years. It has advanced from straight air cooling to low-pressure and then high-pressure hydrogen; in recent years to direct internal cooling of conductors. As each step was taken, generator capacity ratings soared . . . from about 50 mw in the 1930's to 500-mw generators being talked about today.

Some equipment builders in this country are still aiming for a wedding of generator and transformer forming a single unit with a mutual cooling scheme. Space saving is one goal, plus better overall efficiency of generator-transformer. Watt-loss could be recovered as Btu's with relative ease.

Fresh thinking from abroad was recently cabled in by F H Baer from the McGraw-Hill World News office in Vienna. In brief, Elin A.G. has developed what they claim is the first system whereby a generator's winding is kept at uniform temperature at all times through a scheme incorporating a cooling radiator and heat exchanger. With this arrangement hot water can be supplied to the power plant's central heating system. Also, generator windings held at an even temperature should result in even longer trouble-free operation. The Austro-German *Braunau* plant is the first to use this system.

The TD Report this month, starting on p 55, brings this whole changing generator-cooling picture into focus. As pointed out by Assistant Editor Norm Peach, the path being pursued by generator designers is basically one of finding more efficient ways to literally sweep generated heat directly from the conductor without transferring heat through insulation. Today, cooling efficiency has advanced to where essentially all heat developed can be readily removed.

***Power* Special Reports,** some 42 in all, were neatly bound as a leather-covered volume and sent to Karl W Herrmann, mechanical engineer with Kirby Saunders, Inc. Reason: Karl stepped into our booth during last month's Power Show, tried his hand at our "on the beam" test and entered his name for the prize drawing. You weren't as lucky but you can always order a similar volume (cost: $35) from POWER.

Lou Lowley

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly by McGraw-Hill Publishing Company, Inc, James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42nd St, New York 36, N. Y. See box, right, for directions regarding subscriptions or change of address.

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United States subscription rate for individuals in the field of the publication $5.00 per year, single copies $1.00, unless otherwise indicated. Canada; $7.00 for one year. Foreign; $15.00 for one year. Second-class postage paid at New York, N. Y. Printed in U.S.A. Title registered in U.S. Patent Office. ©. Copyrighted 1958 McGraw-Hill Publishing Company, Inc, all rights reserved.

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Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in POWER.

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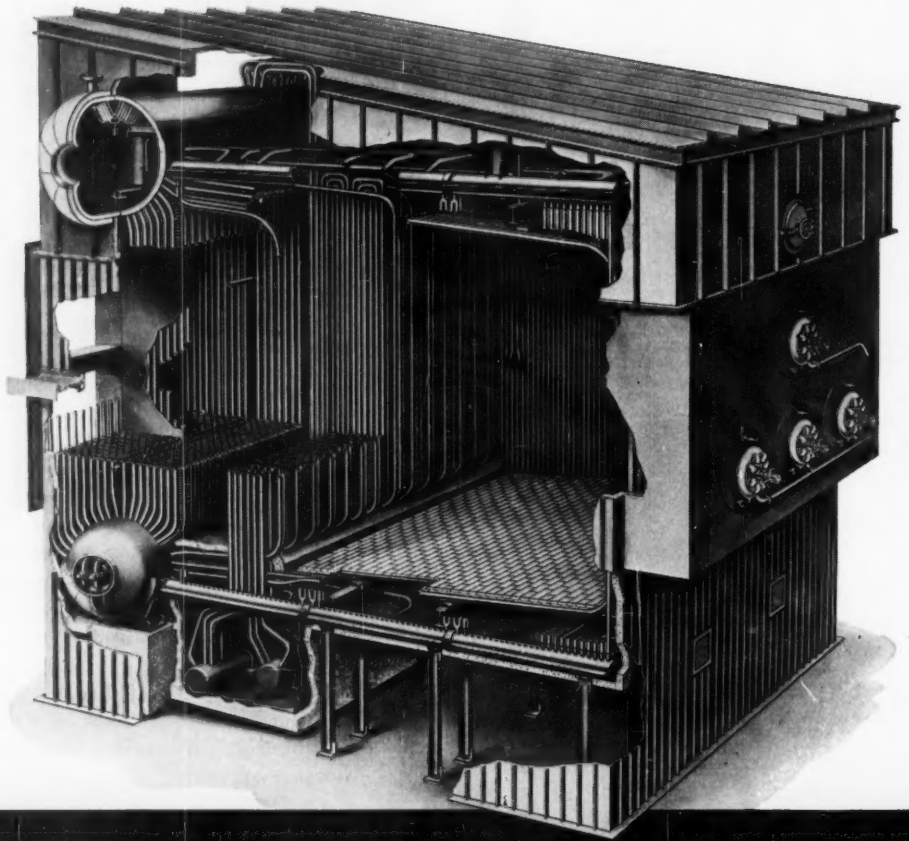
Designed For Tomorrow's New, Economical



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1. It requires a minimum amount of space for a given power output.
2. The pressurized furnace design assures economy by eliminating the induced draft fan and air infiltration. This means savings in cost of fans, fuel, and operating power.
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4. The PFI is designed to burn oil, gas, or a combination of the two. When it is equipped with a dual-fuel burner, it allows you to take advantage of favorable market conditions.
5. Cyclone Steam Separators ensure adequate water circulation which protects boiler tubes from overheating, even with wide and frequent changes in load. They also give you clean, dry steam at all designed ratings with high boiler water concentrations.
6. The drainable superheater design assures quick, safe start-up and ease of storage.
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8. All-welded Membrane Wall contributes to high efficiency and reduces insulation requirements.

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Power For Industry

New B&W
PFI Oil-Gas Burning Unit Provides Maximum Output in Minimum Space

Here's an answer to industry's need for an economical, dependable steam supply. The new B&W Integral-Furnace Boiler produces high-quality, dependable steam economically at all ratings. Aptly named the PFI, the "Power for Industry" Boiler is compact, easy to install, quick to meet rapid and wide load swings. The new boiler gives long, sustained operation, requires little attention and is readily accessible for inspection, cleaning and maintenance.

All responsibility for your complete delivered and erected unit is accepted by one experienced, dependable source which in the past 25 years alone has placed over 4,000 Integral-Furnace Boilers in service. Behind *every* B&W Boiler is nearly a century of leadership in steam generation. A national network of B&W plants and engineering facilities means that the special skills of B&W engineers are always quickly available to you for service and assistance. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

For further information about the B&W PFI Boiler, write for Bulletin G-94.

BABCOCK & WILCOX

BOILER DIVISION

G-899

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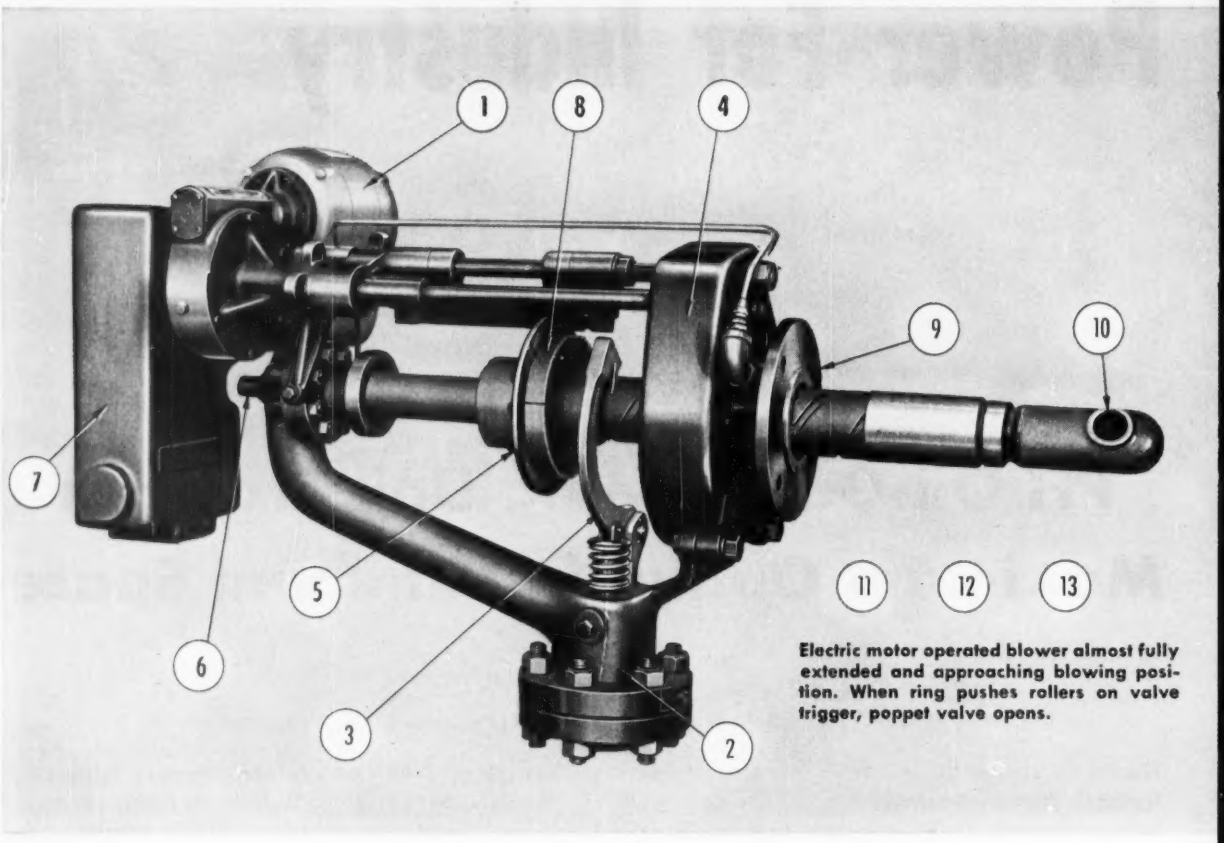
For BETTER Boiler Cleaning



Electric motor operated blower almost fully extended and approaching blowing position. When ring pushes rollers on valve trigger, poppet valve opens.

(1) Single motor (electric or air) both rotates and propels the nozzle

(2) New high-flow poppet type valve assures tight seating without critical adjustment, has welded-in seat with stellited surfaces available.

(3) Positive mechanical action of valve without pilot or diaphragm actuation

(4) Positive mechanical drive through gears for all operations

(5) Valve can open only when nozzle is in blowing position

(6) Adjustable control for individual unit blowing pressure . . . no orifice required in line

(7) Simple, reliable control for local or remote push button operation . . . easily adapted to automatic sequential operation (either air or electric)

(8) Blowing arc easily adjusted for position and extent (up to and including 360°)

(9) Simple mounting on all types of wall construction. No other external support needed. Can mount in any position permitting piping drainage

(10) Improved blower nozzle provides more *available* cleaning energy per pound of steam or compressed air

(11) Completely automatic from start to finish

(12) Suitable for outdoor use without protection except under very severe ice conditions

(13) All operating parts readily accessible for easy maintenance

at LOWER COST

IMPROVED Diamond

MODEL IR BLOWERS

(SHORT RETRACTING LANCE TYPE)

This improved Diamond Model IR Blower does a better job of cleaning water cooled furnace walls, hopper slopes or narrow portions of tube banks adjacent to walls. The retracting feature enables it to operate in zones of extremely high gas temperature; it will remove all dust and most slag deposits over a wide radius from the nozzle.

Cleaning furnace wall tubes effectively reduces gas temperatures leaving the furnace . . . improves overall efficiency of tube bank cleaning. Also, furnace wall cleaning contributes substantially to control of superheat and reheat steam temperatures on high-duty units.

Check the features listed on the left-hand page. For additional information on the improved Model IR, ask your local Diamond office or write directly to Lancaster for a copy of Bulletin 1079U.

Diamond

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

Diamond Specialty Limited, Windsor, Ontario

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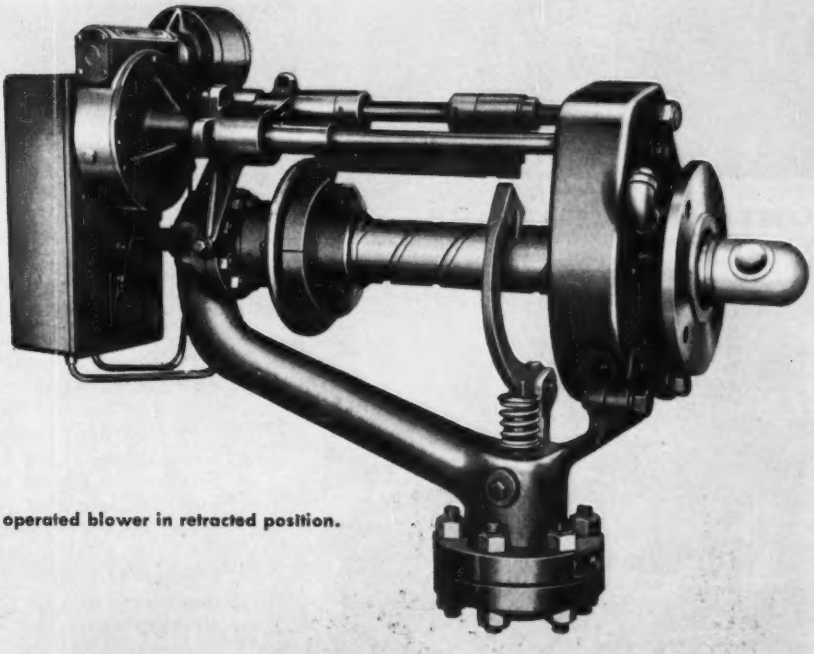


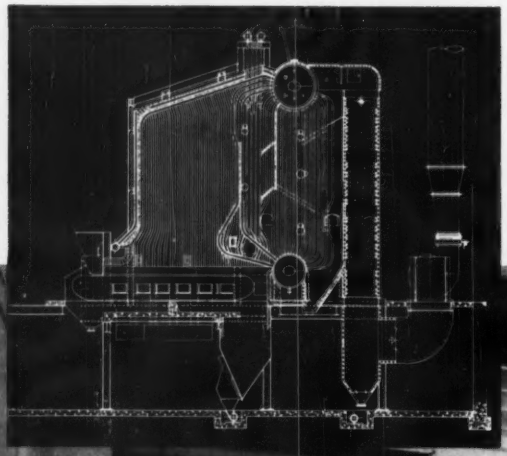
Air motor operated blower in retracted position.

For more facts circle 208 on Reader Service Card, p 100

EFFICIENCY REPORT:

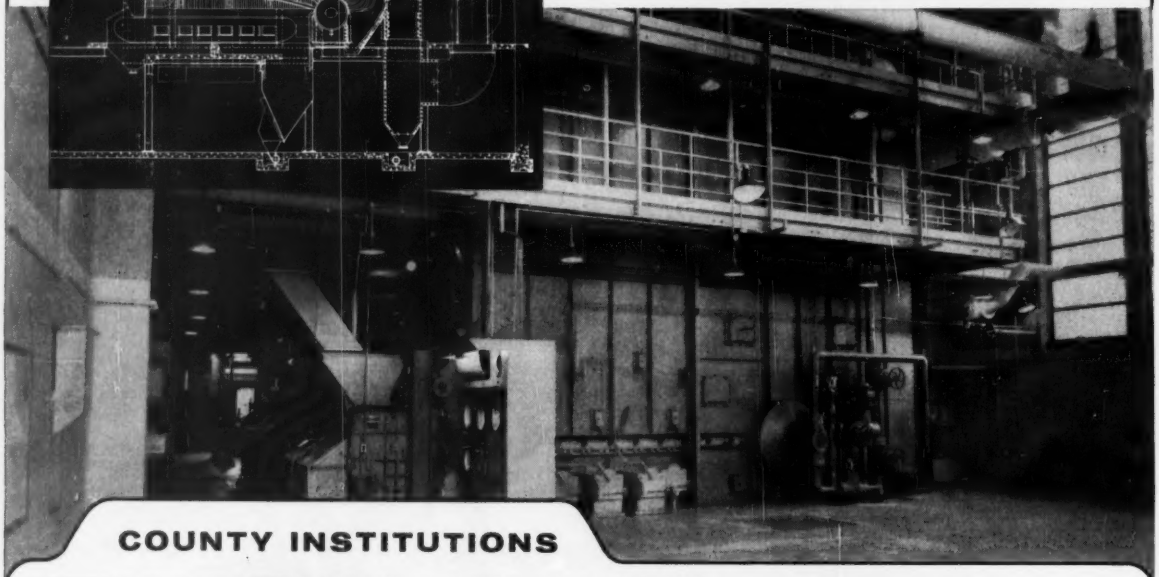
5 Union Boiler installations score top ratings

STATE HOSPITAL



Uninterrupted Low Cost Steam Service

On duty at Mendota State Hospital, Madison, Wisc., this pair of Union 2-drum VO Type Boilers has proved a dependable, economical steam source. Since installation, the hospital's 40 buildings grouped on 384 acres have enjoyed an unbroken steam supply. Individually rated at 50,000 lbs./hr., both units are fired with traveling grate stokers, and together burn 12,000 tons of coal annually.



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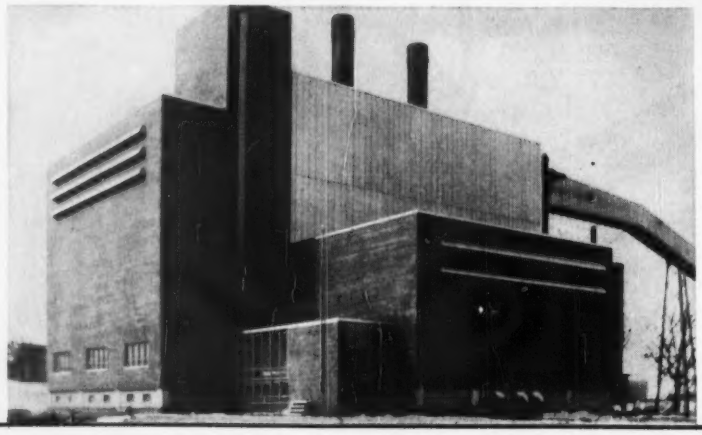


86.52% Efficiency Tops Performance Guarantees

Milwaukee County Institutions — 4 hospitals, a sanatorium, children's home, administration building, and nurses' home . . . 35 million cu. ft. of building in all — rely on three Union 4-drum Type B Boilers to handle **entire steam load** for heat and power. Job-tested at an average individual output of 110,934 lbs./hr., these boilers outstripped performance guarantees with an 86.52% efficiency rating.

UNIVERSITY

Efficiency Upped from 68% to 83%

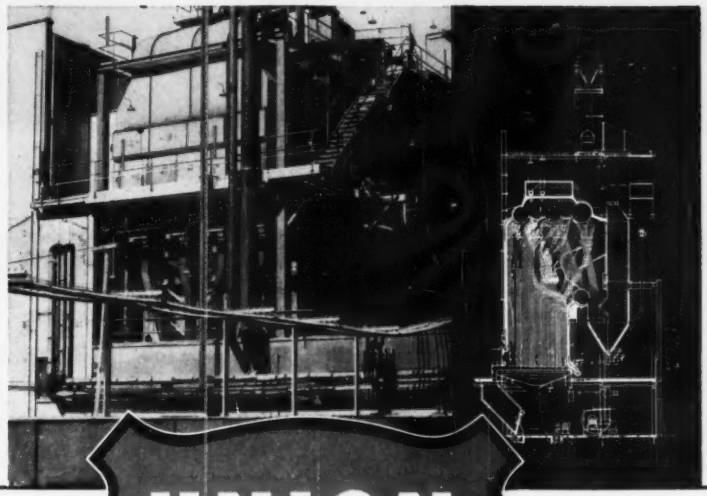
Replacing three of the original boilers, a pair of Union 2-drum VO Type Steam Generators now provides heat and power for entire Notre Dame campus — 75 buildings on 1700 acres. Rated 70,000 lbs./hr., these spreader-stoker units are equipped with superheaters and economizers. Although heating load has been increased 20%, efficiency is up from 68% to 83%.

HOSPITAL-SANATORIUM

86.46% Efficiency Helps Stretch Fuel Dollars

Long term steam costs are held to a minimum by 3 Union Type VO Steam Generators at New Jersey's Essex County Hospital. Serving 75 buildings spread over 553 acres, these 2-drum boilers posted 86.46% in efficiency tests. With unit capacities of 50,000 lbs./hr., they drive two 1000 KW generators, furnish all space heat, drive hot water circulating pumps, and supply steam for cooking, water treatment and deaeration needs.

PAPER MILL



Key Role in Power Modernization Award

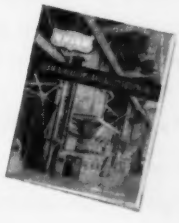
Winner of a Power Modernization Award, John Strange Paper Co. installed a Unic ı 4-drum Steam Generator to supply steam for electrical power and processing. With capacity of 165,000 lbs./hr. at 725 psig and 825°F., this Union semi-outdoor boiler has played a key role in boosting production 10% while saving 29% in fuel costs without increasing plant personnel.

UNION

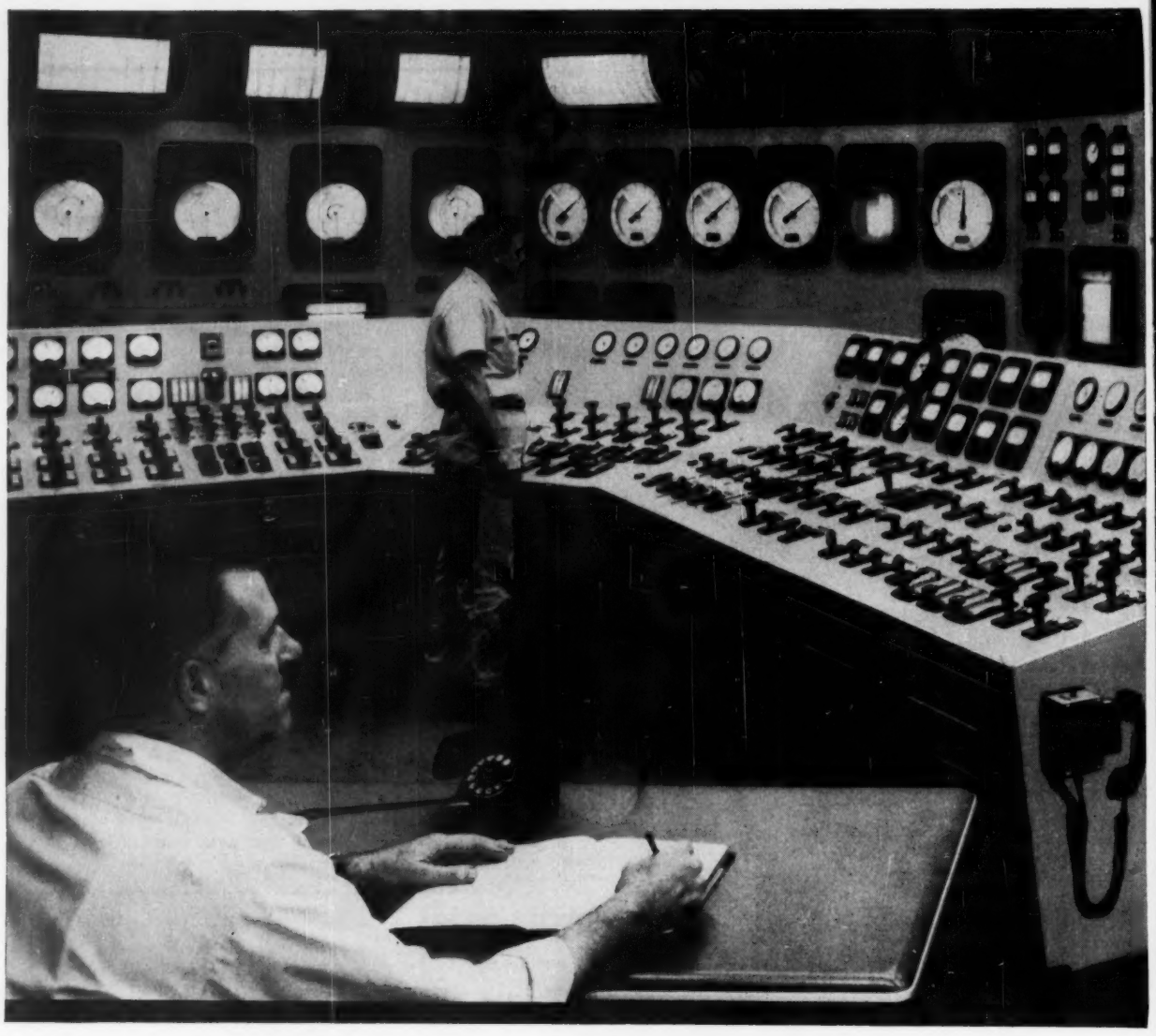
UNION IRON WORKS
ERIE, PENNSYLVANIA

LIKE MORE DETAILS?

Union Steam Generators are built in many sizes and types, and can be outfitted to meet a wide range of requirements. Send for illustrated Catalog GB-958.



For more facts circle 209 on Reader Service Card, p 100



How Bailey makes steam

Fingertip Controls, convenient indicators, and trend recorders make steam control room operating duties a pleasure. You get this bonus for your operators when you specify Bailey Meters and Controls.

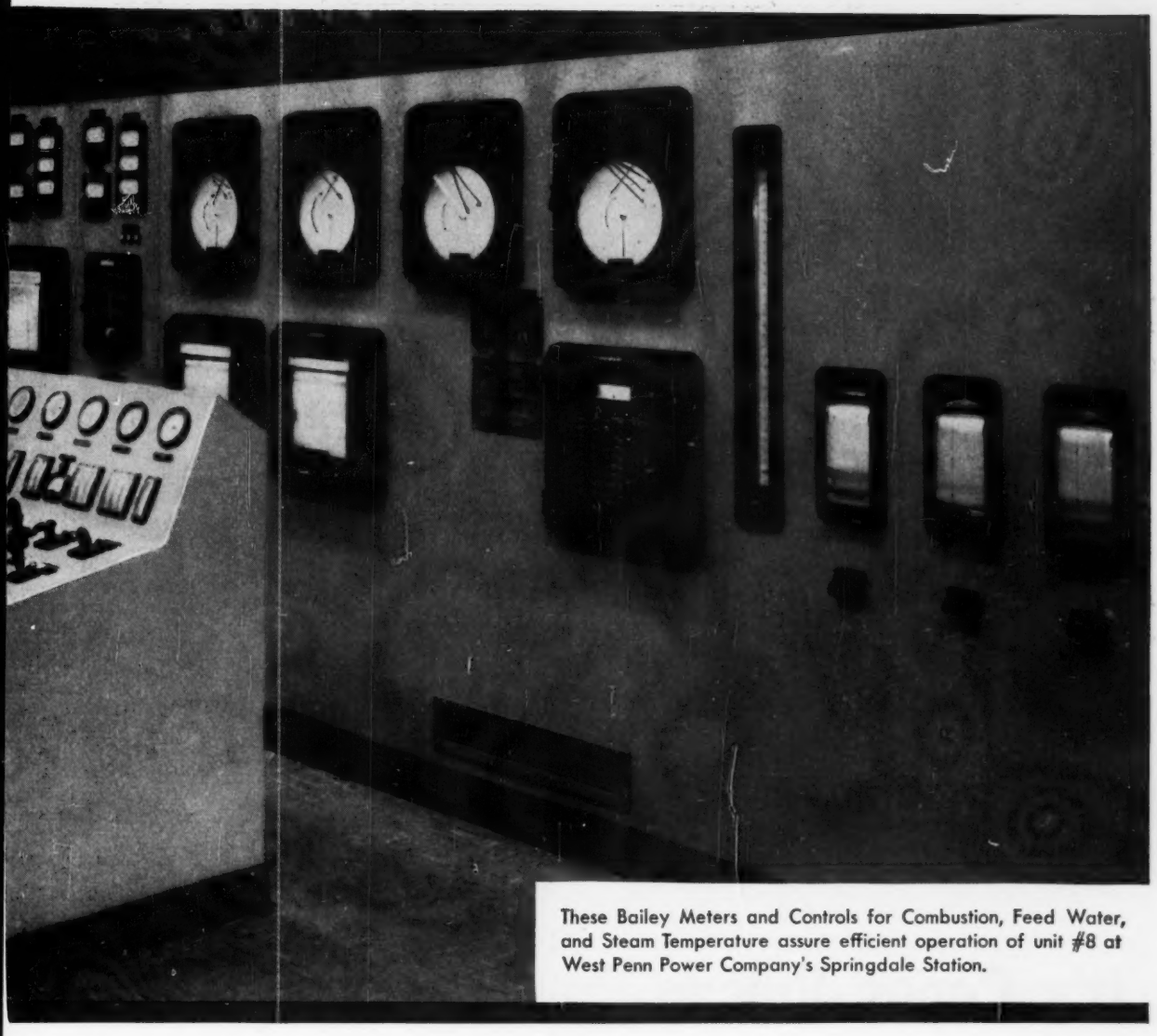
Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men



These Bailey Meters and Controls for Combustion, Feed Water, and Steam Temperature assure efficient operation of unit #8 at West Penn Power Company's Springdale Station.

operating duties a pleasure

who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A133-2

BAILEY METERS

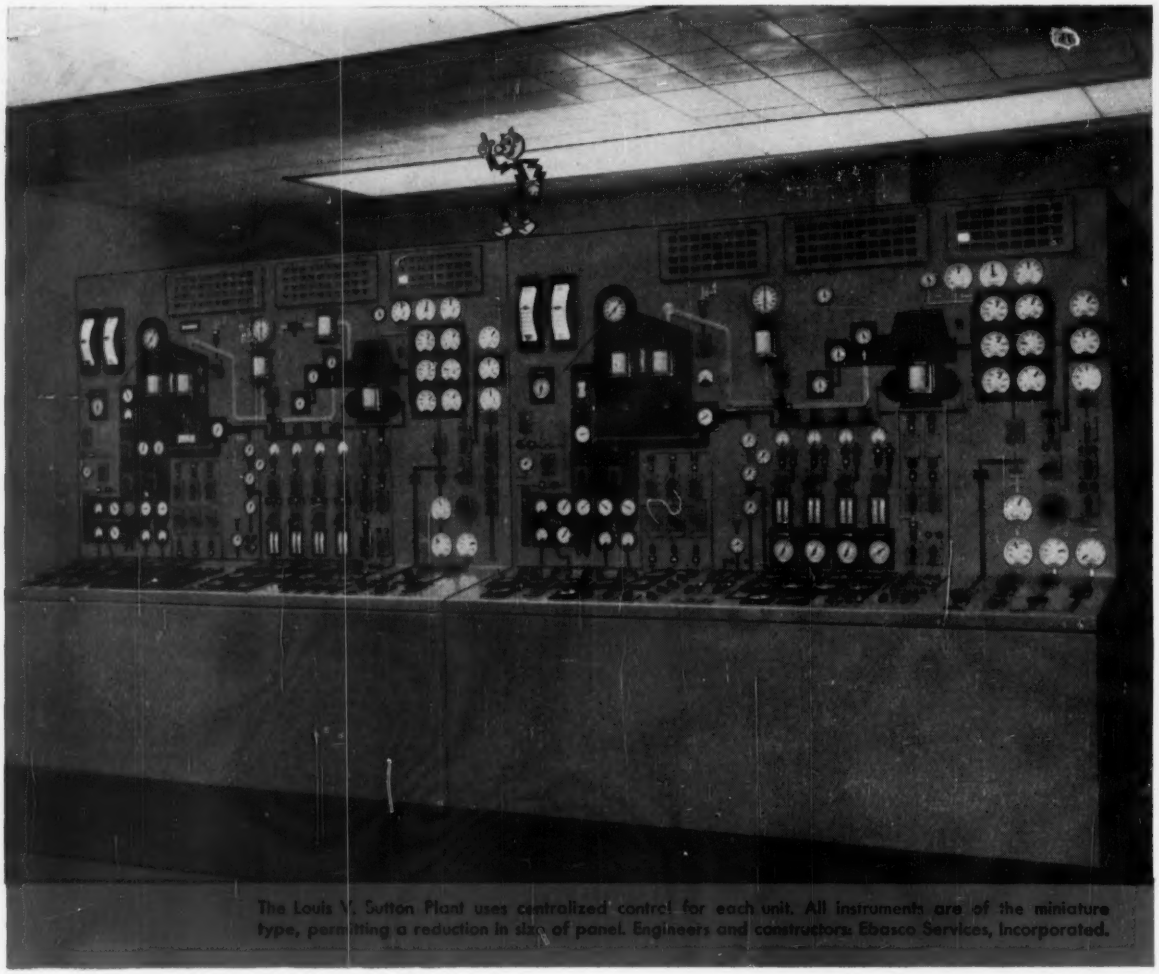
Instruments and controls for power and process

BAILEY METER COMPANY

10 36 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more facts circle 210 on Reader Service Card, p 100



The Louis V. Sutton Plant uses centralized control for each unit. All instruments are of the miniature type, permitting a reduction in size of panel. Engineers and constructors: Ebasco Services, Incorporated.

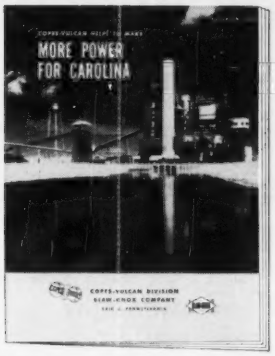
It's Copes-Vulcan Combustion Control at Louis V. Sutton Plant!

Units 1 and 2 in the Louis V. Sutton Steam-Electric Generating Plant of Carolina Power & Light Company are equipped with Copes-Vulcan combustion control. This modern system features simplicity of circuit design, with independent control loops on air flow, fuel loading and furnace draft. Interconnection of the control loops is eliminated because of the speedy response of each of the components.

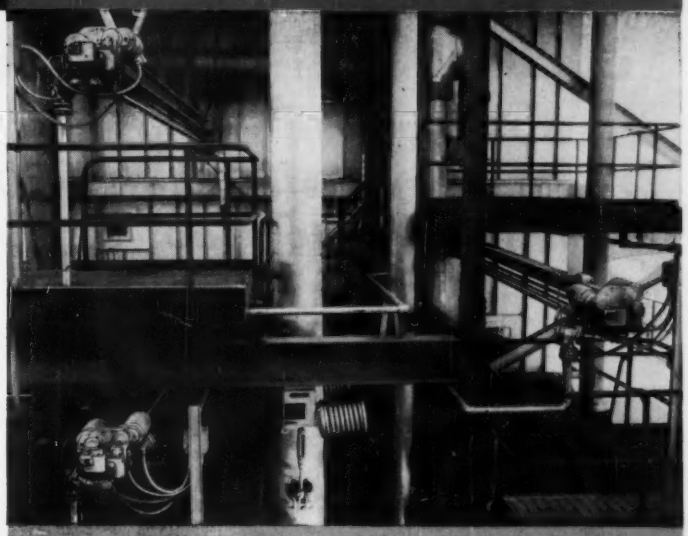
Station and controller design facilitates remote switching from automatic to manual, or manual to automatic. Variations in circuit design would provide for shortening tubing runs between controllers and drive units, valves or other controlling devices, should transmission lines become excessively long.

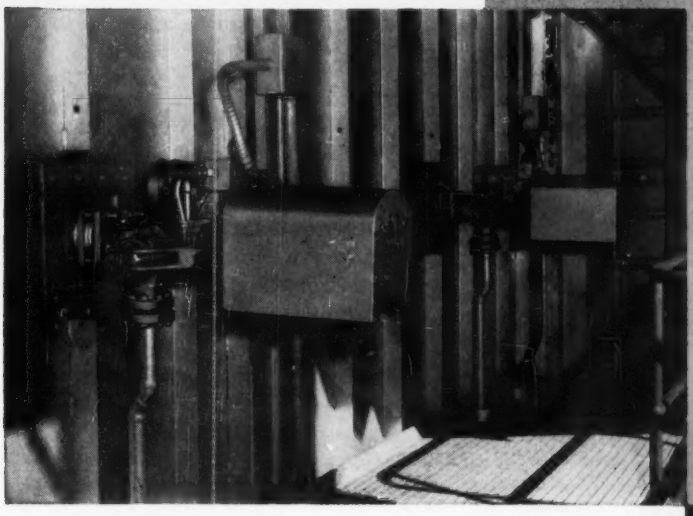
Modern Copes-Vulcan combustion control systems offer many advantages that will help you reduce production costs. In addition, from this one dependable source, you can get a fully integrated system including feed water control, boiler feed pump recirculation control, steam temperature control and automatic soot blowing. Your Copes-Vulcan representative has the ideas, information and experience to help you choose the system best suited to your needs.

C-V NEWS NOTES



For a complete description of the Sutton Plant control system, see your Copes-Vulcan representative, or write the factory for Bulletin 1032.

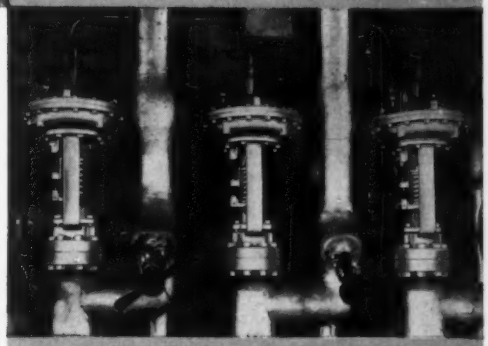




Vulcan long retractable soot blowers are installed on Units 1 and 2. Both soot blowing systems feature automatic-sequential control.

Copes-Vulcan RW-2E wall de-slaggers on Unit 2 have dual-motor electric drive. One motor extends and retracts the lance, the other rotates the nozzle.

COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

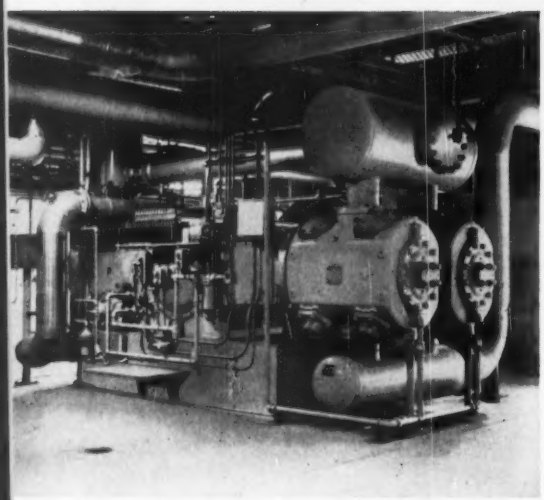


Copes-Vulcan boiler feed pump recirculation valves on Units 1 and 2 open automatically when water flow falls below a pre-determined minimum. When flow reaches a pre-determined maximum controller closes the valve.

For more facts circle 211 on Reader Service Card, p 100

Specifies AIR for furnace and tube bank

. . . another installation of Cooper-Bessemer compressors for soot blowing service



Typical installation of Cooper-Bessemer FM air compressors for soot blowing service—El Segundo Station of Southern California Edison Company. This unit is rated 500 hp at 400 rpm.

On the banks of the Wabash, the new Breed Station of Indiana & Michigan Electric Company will stand out as a symbol of sound, far-sighted engineering. Designed by and built under supervision of the American Electric Power Service Corporation, this 450 megawatt steam generating station will embody the latest advances in power plant methods and equipment. Take furnace and tube bank cleaning for example . . .

The Cyclone-fired furnace of this modern station will be cleaned by compressed air. Three 600 hp Cooper-Bessemer Type FM compressors will deliver a total of 6100 cfm for soot blowing service.

One after another, power companies and their consultants are specifying this improved method of boiler cleaning as the solution to many problems. And for authoritative advice and the latest in facilities, they are turning to Cooper-Bessemer. Soot blowing is one of the many fields in which Cooper-Bessemer is able to render an outstanding service. Write for complete details.

BRANCH OFFICES: Grove City • New York • Chicago • Washington • San Francisco • Los Angeles • Houston • Dallas • Odessa • Pampa • Greggton • Seattle • Tulsa • St. Louis • Kansas City • Minneapolis • New Orleans • Shreveport

SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary • Toronto

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Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE OR MOTOR DRIVEN

For more facts circle 212 on Reader Service Card, p 100

cleaning at new Breed Station

ECONOMICS OF BOILER CLEANING WITH COMPRESSED AIR

(Versus Steam)

1. Pressure is always adequate to do clean, thorough job.
2. Better programming with air . . . gets better cleaning results for higher boiler efficiency.
3. Lower cost for blowing medium . . . less waste.
4. No quenching action on hot alloy tubes or pressure vessels.
5. Less maintenance of blower equipment due to erosion, corrosion, packing wear.
6. Improved housekeeping . . . no steam or condensate leakage.
7. Greater over-all economy of blowing medium on evaluated basis.
8. Eliminates condensate makeup required when blowing with steam.

DATA—Write for free copy of "Steam or Air: Which costs more for boiler cleaning?"

Breed Station of Indiana & Michigan Electric Company, located in western Indiana. Designers: American Electric Power Service Corporation.

now fully

YARWAY REMOTE BOILER

With the addition of the new pressure compensator described on opposite page, full-scale accuracy of water level indication is provided not only at "working pressure" but *also at all other boiler pressures.*

The Yarway Remote Indicator now offers *completely accurate readings of the boiler water level under every operating condition.*

For complete information on Yarway Indicators and pressure-temperature compensation, write for Bulletin WG-1814 and new compensator supplement.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NOTE: Ask about the application of Yarway Indicators for 900 psi and higher pressures under Boiler Code Case 1155 (two indicators in place of one of the two required gage glasses).

YARWAY®

...a good way

compensated *
WATER LEVEL INDICATORS

ADVANTAGES OF YARWAY PRESSURE COMPENSATOR

1. Compensating mechanism is applied to the Yarway indicator without change in internal construction of the indicator.

2. Well-known dependability of bourdon tube insures reliability and long life.

3. Trouble-free operation because linkage is simple and direct.

4. For maximum sensitivity, the indicator pointer is mounted on jewel bearings.

5. Rugged shock-resistant mounting carries weight of compensator mechanism without burdening the pointer mechanism.

6. Boiler conditions are readily simulated for check of instrument calibration at operating pressures, with remainder of indicator system under atmospheric pressure.

7. Application of pressure-temperature compensation for density changes in boiler water insures desired accuracy of level indication at all operating pressures and at all points on the pointer scale.

**Pressure compensator available on request, at extra cost.*

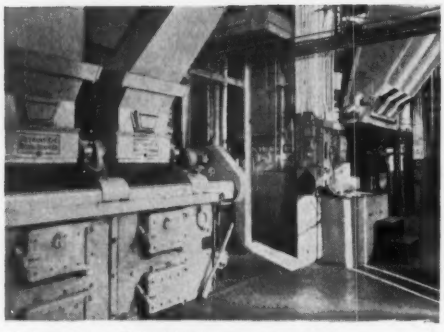
Model showing mechanism of Yarway Pressure Compensator. Placed between indicator operating and indicating elements, the compensator mechanism corrects the level indication by changing pointer travel to compensate for variation in water density due to changes in boiler pressure.

(Not shown) Yarway Remote Hi-Lo Alarm Signals (lights and/or horns), operated by the Indicator. May be placed at any location in the plant.

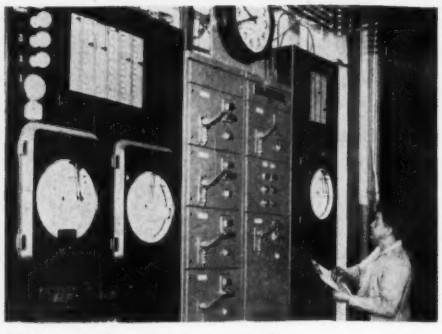
(Not shown) Yarway Electronic Secondary Indicator to provide duplicate reading at any other location. Same size and appearance as primary indicator.

to specify remote liquid level indicators

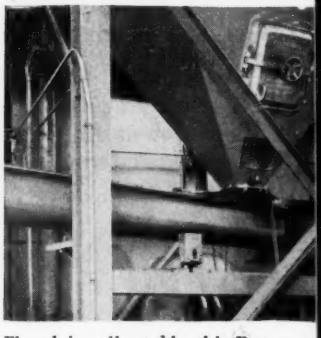
For more facts circle 213 on Reader Service Card, p 100



Firing aisle of Carlisle's power plant. Left foreground is new 20,000 lb/hr boiler by E. Keeler Co., fired by Detroit Rotostokers. In the rear is an Erie City Water Tube Boiler (equipped with Erie City Spreader Stokers), used as stand-by unit.



Close-up of control panel, by Hagan Corp. These controls—regulating furnace draft, steam flow, air flow, flue gas temperature, stoker control—constitute a complete, automatic combustion control system.



Fly ash is collected by this Prat-Daniel Mechanical Precipitator. Fly ash is gravity-fed from the hopper (at top of photograph) into completely-enclosed screw conveyor which moves it cleanly to the disposal point.

Carlisle Tire takes fuel costs for a ride

With increased fuel efficiency, Carlisle Tire and Rubber burns coal . . . holds costs to minimum while upping production 20%

At the Carlisle Tire and Rubber Division of Carlisle Corp., Carlisle, Pa., the steam produced by the power plant is used primarily for processing. As production of bicycle tires, inner tubes and other rubber products increased, the firm's engineering department decided to boost steam capacity with modern coal-burning facilities. Coal was used on the basis of cost—25% less than the nearest competitive fuel. The result has been a dependable steam supply, cleanliness of operation and a jump in operating efficiency. Today the plant consumes the same tonnage of coal as before modernization although production has increased 20%!

Coal is lowest-cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest-cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Technical advisory service

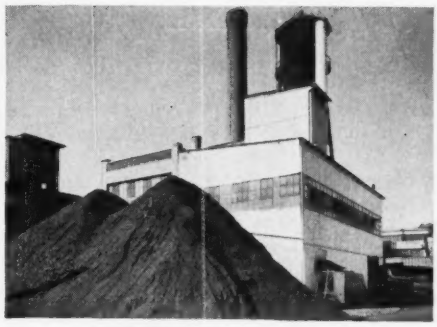
To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

BITUMINOUS COAL INSTITUTE

Department P-01, Southern Building, Washington 5, D. C.



Exterior view of Carlisle's power plant. From outside storage area, coal is moved to 32-ton bunker inside and fed by screw conveyor to coal hoppers. Coal handling system is by Jeffrey Manufacturing Co.

SEND COUPON FOR NEW "Guide Specifications for Underfeed Stoker Fired Low-Pressure Heating Plants." Heavy demand for the first edition of this booklet, adaptable for design loads 3,000 to 26,000 EDR steam, has justified an expanded edition covering application of underfeed stokers to firetube, watertube and sectional cast iron boilers. Complete specifications criteria cover all aspects of typical heating plant.

Bituminous Coal Institute, Southern Building, Washington 5, D. C. P-01

Gentlemen: Please send me:

☐ Guide Specifications Booklet ☐ Case histories on larger plants

☐ I am interested in your advisory service

Name_____

Title_____

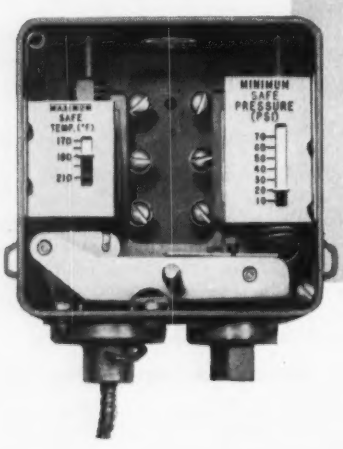
Company_____

Address_____

City_____ Zone_____ State_____

For more facts circle 214 on Reader Service Card, p 100

Temperature and pressure set points are inside the case, protected against accidental manipulation. Cover is removed for easy adjustment.



New Diesel engine safety switch

...gives fail-safe protection

This all-new Honeywell safety switch responds to abnormal pressure or temperature to stop or idle a diesel engine, or actuate an alarm circuit.

It combines separate systems for measuring engine coolant temperature and lubricating oil pressure. The temperature system includes an exclusive fail-safe feature, so that in case of damage to its temperature bulb, capillary or diaphragm, the switch responds as it would to excessive temperature.

Temperature and pressure settings can't drift off set points. There can be no false shutdowns due to vibration. Set points are easily adjustable in the field.

Your nearby Honeywell field engineer will be glad to give you complete information about the new Diesel Engine Safety Switch. Call him today . . . he's near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

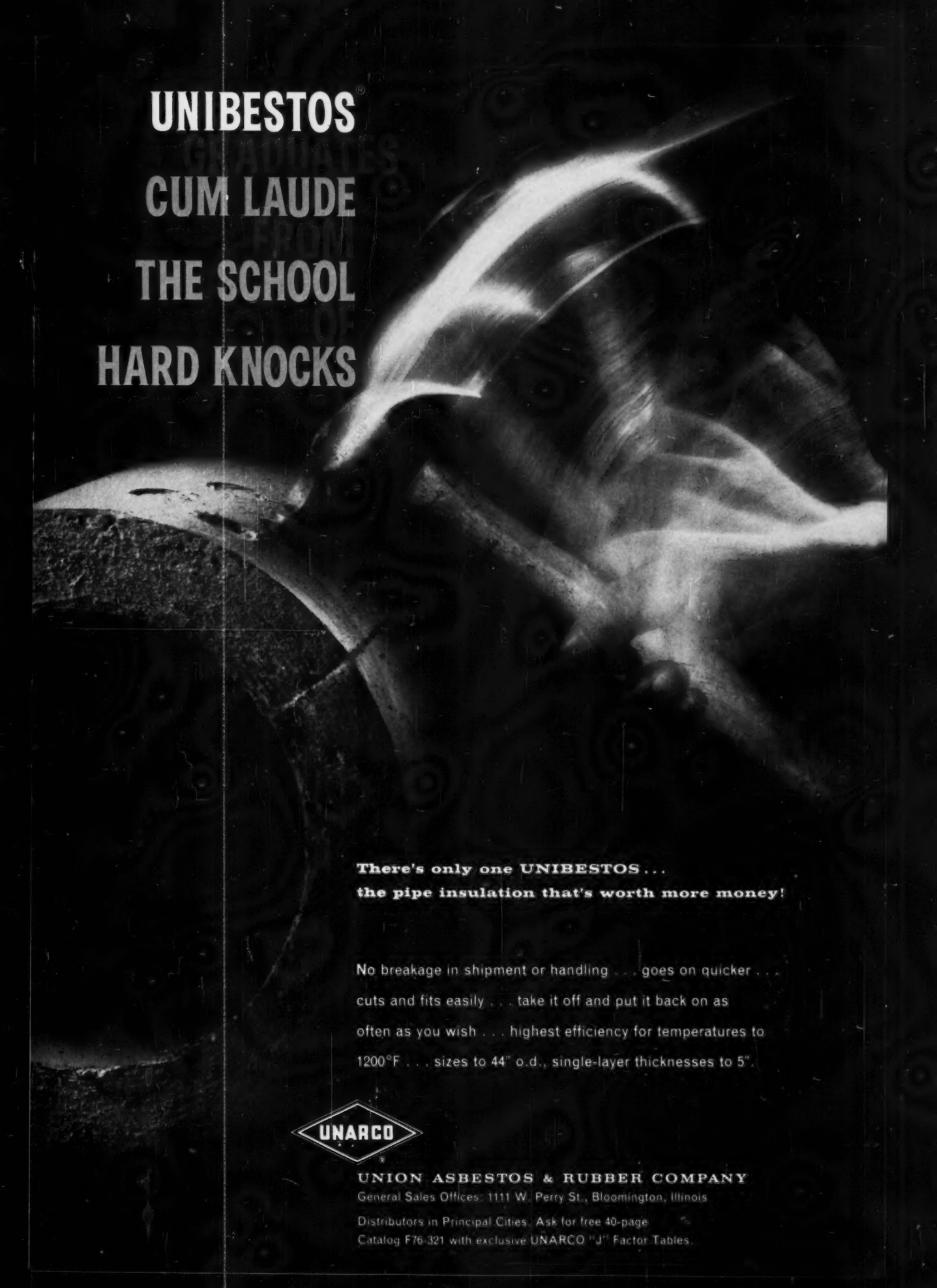
● **REFERENCE DATA:** Write for Specification sheet S1010-5 "Diesel Engine Safety Switch."

Honeywell

H HONEYWELL *First in Control*

For more facts circle 215 on Reader Service Card, p 100

For more facts circle 216 on Reader Service Card, p 100 →



There's only one UNIBESTOS . . .
the pipe insulation that's worth more money!

No breakage in shipment or handling . . . goes on quicker . . . cuts and fits easily . . . take it off and put it back on as often as you wish . . . highest efficiency for temperatures to 1200°F . . . sizes to 44" o.d., single-layer thicknesses to 5".

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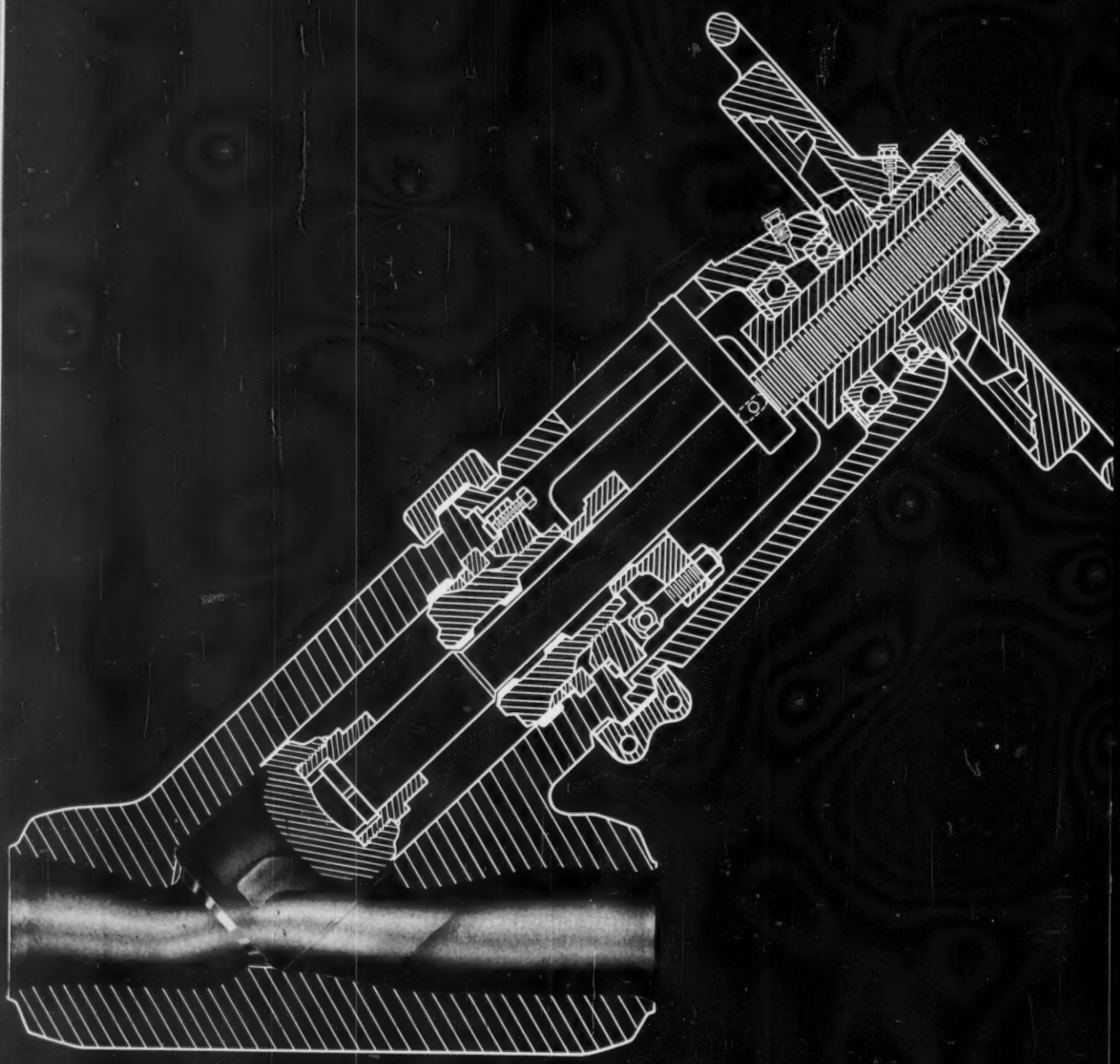
UNION ASBESTOS & RUBBER COMPANY
General Sales Offices: 1111 W. Perry St., Bloomington, Illinois

Distributors in Principal Cities. Ask for free 40-page Catalog F76-321 with exclusive UNARCO "J" Factor Tables.



NEW EDWARD "FLITE-FLOW" VALVE

What's New from Edward Valves, Inc.

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

New Flite-Flow* Valve Cuts Pressure Drop 70%

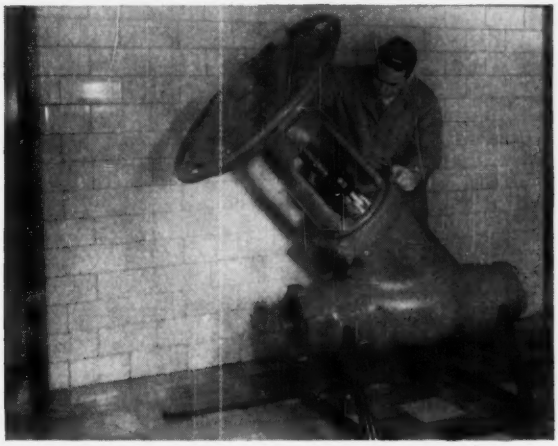
. . . yet provides full globe valve tightness and repairability

Through basic characteristics of its design, only a hard seat globe-type valve can be depended upon to give drop-tight shutoff under high-pressure, high-temperature conditions. But conventional globe valves also produce serious pressure-drop problems—which intensify in the trend toward larger-capacity, higher-pressure plants with their higher-velocity flow rates.

Briefly stated, this was the problem given to Edward engineers. In their continuing program of valve development, these men had singled out turbulence in the flow path as a key area for study. They charted the effects of re-shaping flow passages . . . of shifting valve seat location . . . of *pre*-shaping the flow as it approaches the seat.

Low turbulence factor

All tests confirmed that total pressure drop was least when turbulence was minimized in the three most critical areas: ahead of, at *and beyond the seat.* In the final design, flow approaching the seat is pre-shaped to provide a special "squirting action" which carries the fluid smoothly across the seat. The downstream side of the passage is shaped to receive this flow and send it on with a minimum of eddy and turbulence.



The net result of years of research and development, Flite-Flow is available in sizes 10" and larger.

The result is Flite-Flow, a globe valve with drop-tight shutoff *and* negligible pressure drop, as shown in the tables below:

FEEDWATER SERVICE

In 500-F, 3000-psi feedwater service on a 1,500,000 lb/hr unit, the following performance of 12-inch valves has been recorded:

Ordinary globe valve ... 10-15 lb drop
EDWARD FLITE-FLOW VALVE ... 2.1 lb drop
Good gate valve ... 1.0 lb drop

STEAM SERVICE

In 1050-F, 1900-psi steam service at 800,000 lb/hr through a 12-inch valve, the following performance has been recorded:

Ordinary globe valve...64 lb drop
EDWARD FLITE-FLOW VALVE ... 11 lb drop
Good gate valve ... 2 lb drop

OTHER IMPORTANT FLITE-FLOW FEATURES:

- RESISTANCE TO THERMAL DIFFERENTIALS —a real design and metallurgical achievement.
- REPAIRABILITY OF SEATING SURFACES —while valve is in the line.
- PIPING VERSATILITY —fits any piping plan. Unique design assures accurate guiding of disk whether stem extends up, down or horizontally.
- IMPROVED OPERATING MECHANISMS —manual, pneumatic, electric.
- INTEGRAL SEAT CONSTRUCTION —inlaid stellite seat, machined and lapped in same set-up as body bore for perfect alignment.

EDWARD VALVES, INC.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1230 West 145th Street, East Chicago, Indiana

Represented in Canada by

LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St., W. Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 psi; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T. M. Reg. U. S. Pat. Off.

For more facts circle 217 on Reader Service Card, p 100

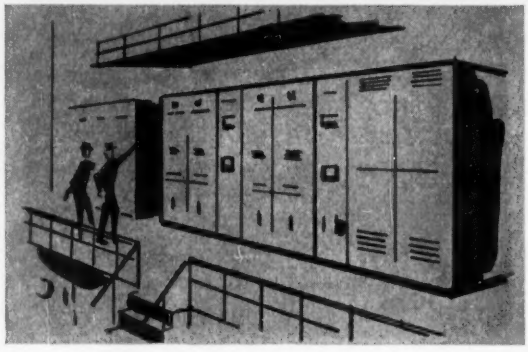
Here's why it pays to Specify Silicone Insulated Transformers

A New Level of Performance for Power Station Auxiliaries

Insulated with silicones, dry-type transformers are so completely safe, you can locate them almost anywhere. Easier and less costly to install than liquid-filled types, they require no vaults, barriers or ventilating fans. And when installed, they offer the best assurance of uninterrupted power because Dow Corning Silicones mean extra overload capacity . . . superior resistance to high ambients, moisture and contaminated atmospheres. Here's how to select the dry-type transformer most suited to your needs —

for maximum reliability, minimum maintenance

Specify a silicone-insulated *sealed* dry-type transformer. With core and coils sealed in an atmosphere of nitrogen, these units have no liquids to maintain . . . require only a periodic check of pressure gauge and bushings . . . are virtually maintenance-free.

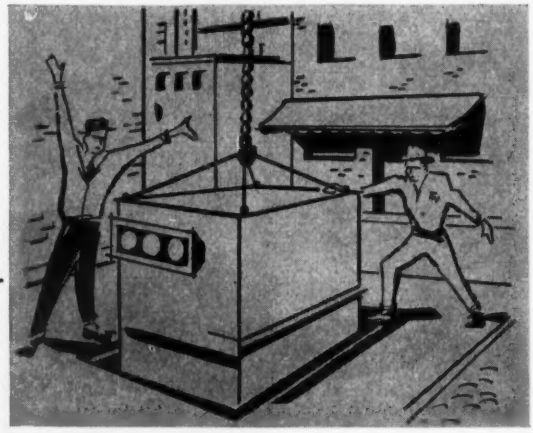


for minimum weight

Specify a silicone-insulated *open* dry-type transformer. Lighter by 15% than the next lightest type, these units are ideal for balconies and other areas where minimum floor loading is a must.

A New Level of Performance for Underground Distribution Systems

Silicone-insulated, nitrogen-filled *network* transformers require so little upkeep, they can be buried and virtually forgotten. They are undamaged even when flooded. Only the bushings, pressure gauge and case require periodic inspection. Dry-type transformers fit easily into existing vaults; are completely safe even in case of extreme overloads or short circuits.



Send today for your copy of new brochure detailing how you can save with silicone insulated dry-type transformers. Includes up-to-date list of manufacturers offering equipment insulated with Dow Corning Silicones.

Address Dept. 6913

first in silicones

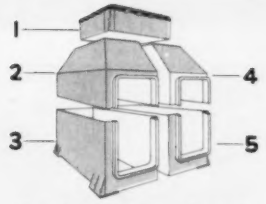
Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D. C.

For more facts circle 218 on Reader Service Card, p 100

For more facts circle 219 on Reader Service Card, p 100 →

This 75,000 square foot condenser pre-assembled and pre-fitted at Maryland was shipped in 5 compact maximum rail clearance sections.



5-piece Maryland condenser design

Horizontal division separates the neck section (1). The main body of the condenser is divided both vertically and horizontally, as shown by sections numbered (2), (3), (4) and (5).

Maryland's 5-Piece Condenser

Designed for Low Cost Field Erection

Maryland designed, built, pre-fit and pre-assembled this 75,000 square foot condenser in five compact sections for accurate and low cost field erection.

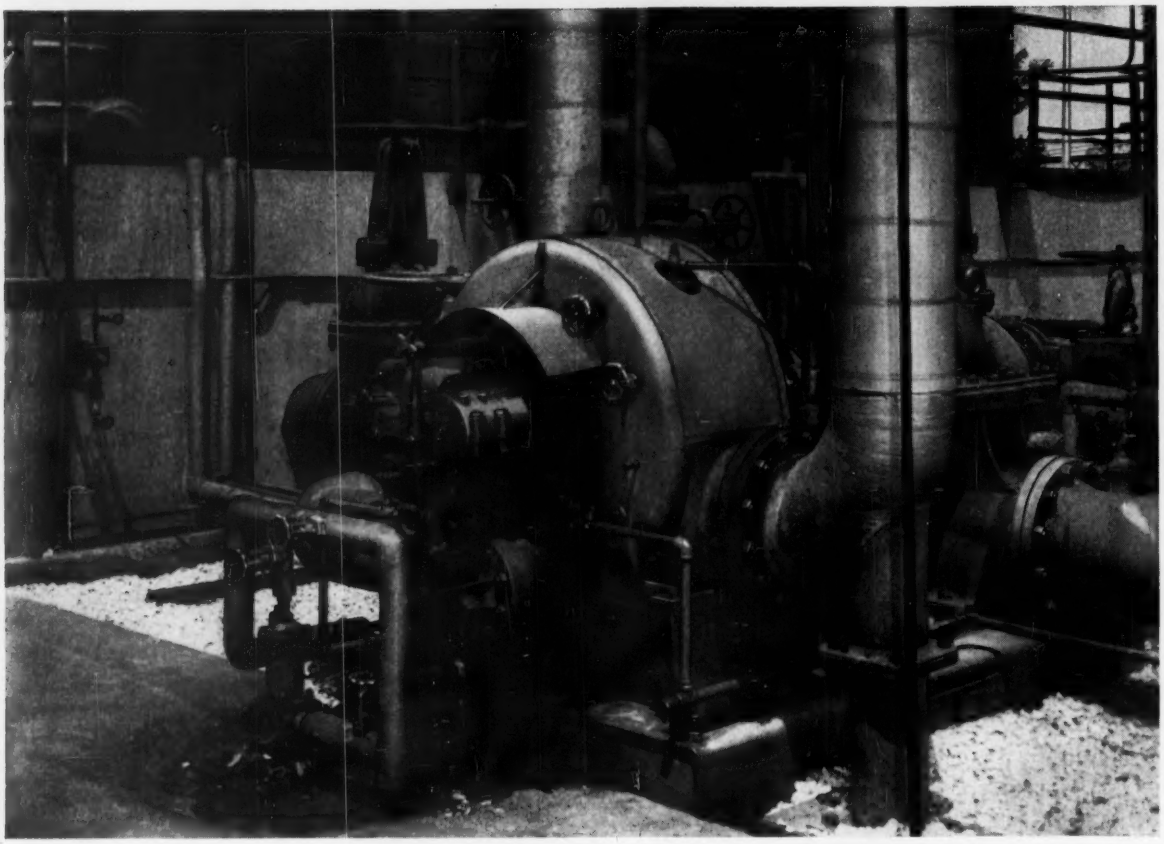
Now being installed at Reesedale, Pennsylvania in West Penn Power's Armstrong Station, this unit indicates Maryland's ability to engineer and build large surface condensers for electric utilities. It will condense 812,819 pounds of steam per hour exhausted from a 156,250 KW Westinghouse turbo-generator, and its full deaerating hotwell will produce condensate with no more than .01 cc of oxygen per liter.

When *your* plans call for steam surface condensers, consider the advantages offered by Maryland's years of engineering experience and facilities for designing and manufacturing condensers, of any size.

Industrial Products Division

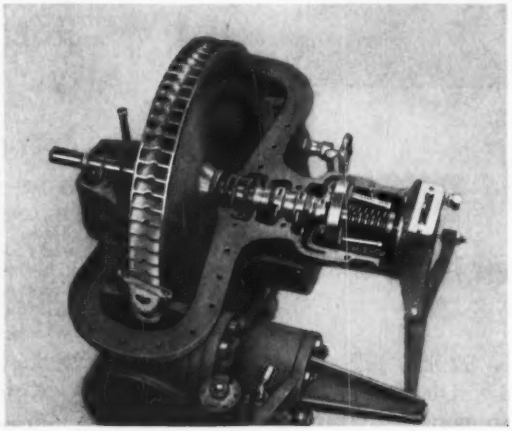
MARYLAND SHIPBUILDING & DRYDOCK COMPANY

BALTIMORE 3, MARYLAND • *Representatives in Principal Cities*



TERRY SOLID-WHEEL TURBINES

used exclusively at Baton Rouge plant of W.R.Grace & Co.



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1214

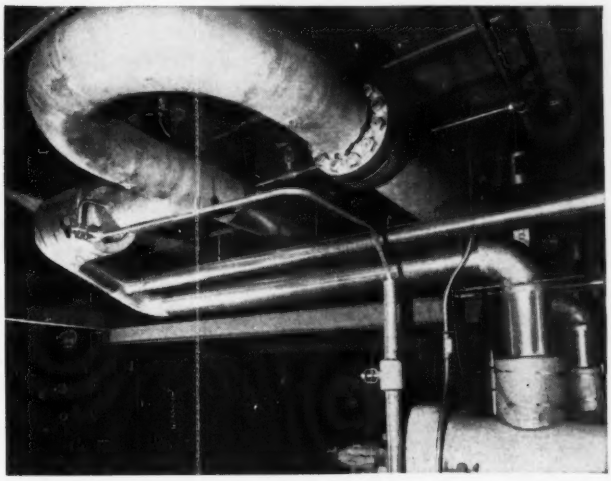
For more facts circle 220 on Reader Service Card, p 100

For more facts circle 221 on Reader Service Card, p 100 →

25 YEARS* OF SATISFACTION with MIDWEST PIPING

That is the experience of THE HAWAIIAN ELECTRIC COMPANY

Of the eight piping contracts the Hawaiian Electric Company placed with Midwest during the past quarter century, two were for the L. A. Hicks Plant shown above.



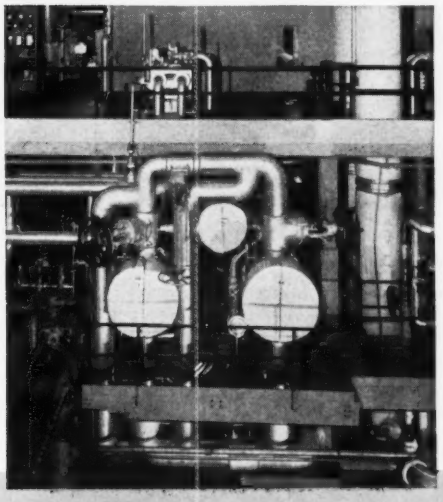
Boiler feed piping fabricated and installed by Midwest for the last unit in the L. A. Hicks Plant in Honolulu.

Benefits that Hawaiian Electric and many other electric utilities get by using Midwest Piping include:

- Unequalled experience of Midwest fabrication and construction organizations.
- Erection planning by staff engineers before fabrication.
- Accurately fabricated subassemblies that simplify and expedite field erection.
- Convenient locations of three fabricating plants.
- Continuous piping research and development.

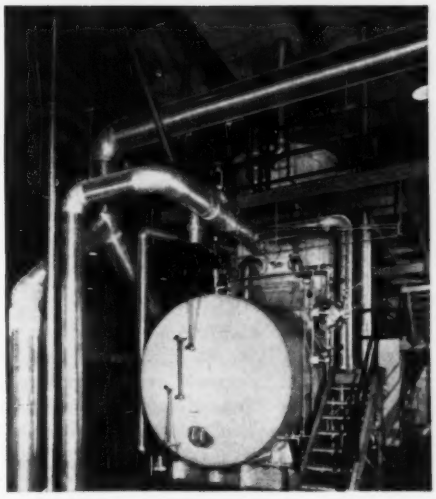
This adds up to a better piping job . . . on time and at minimum cost. It will pay you to call in Midwest the next time you need piping.

*** 8 CONTRACTS SINCE 1933**



(Left) Showing Midwest Piping for horizontal and vertical feed water heaters for last two units at L. A. Hicks Plant.

(Right) Main steam and deaerator piping for last unit. Design conditions are 1500 psi and 950°F.



8093

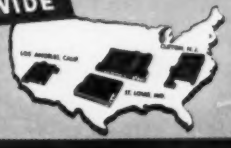
MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Mo. (P. O. Box 433)

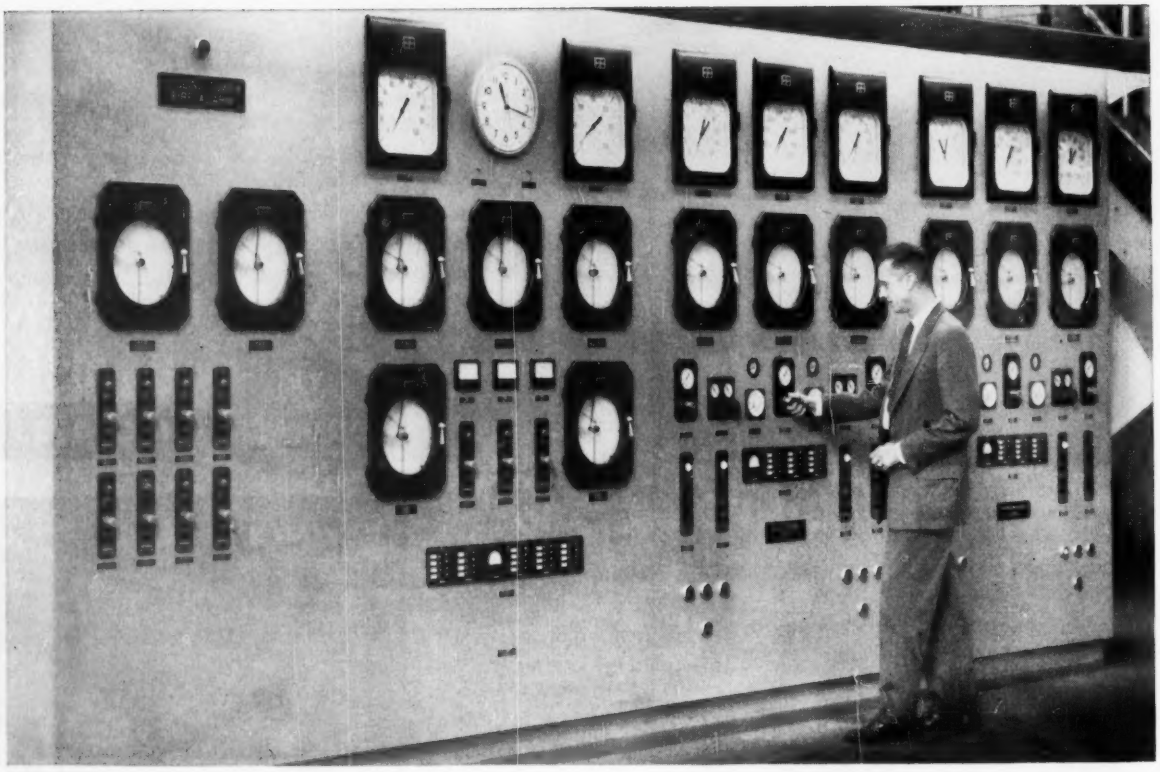
PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

SALES OFFICES: Asheville (Box 446, Skyland, N.C.) • Atlanta 9—72 11th Street, Northeast • Boston 27—426 First Street
Chicago 3—79 West Monroe St. • Cleveland 14—616 St. Clair • Houston 2—1213 Capitol • Los Angeles 33—520 Anderson
Miami 34—2103 Le Jeune • New York 7—50 Church St. • Pittsburgh 19, Pa.—437 Grant • San Francisco 11—420 Market St.
St. Louis 4, Mo.—1450 South Second St. • Tulsa—1640 East 21st St.

MIDWEST PIPING SERVICE IS NATIONWIDE



CAPITOL HILL RECORDS COOLING



Central Supervisory Panel for Capitol Power Plant cooling system, Washington, D. C. Variables recorded by Taylor instruments include: Condenser Water Temperature and Flow; Outdoor Temperature and Humidity; Tons of Refrigeration; Chilled Water Flow in both East and West Tunnels; and Chilled Water Temperature and Pressure.

The Taylor Multiplying Linkage System multiplies temperature differential and flow to give tons of refrigeration, enabling the operator to evaluate the performance of the entire cooling plant from this master panel.

Taylor Instruments

EFFICIENCY WITH TAYLOR INSTRUMENTS

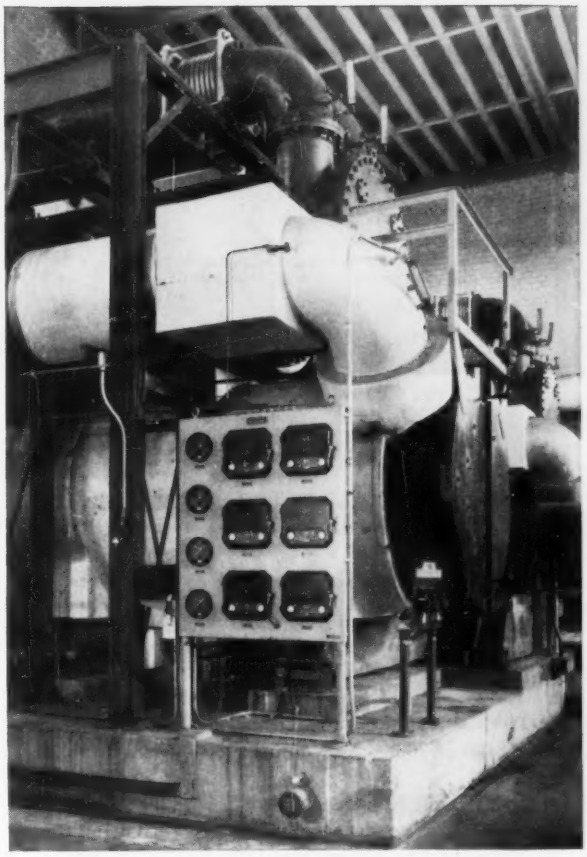
TAYLOR instruments at the Capitol Power Plant perform two important functions. They indicate and/or record the BTU performance of the cooling system on a central supervisory panel, thus enabling the operator to run the plant at maximum efficiency.

The new Capitol System has been in operation for over a year now, and the Power Plant Supervisor reports complete satisfaction with the performance of the equipment and the instrumentation. The new installation uses four York centrifugal compressors to provide 8800 tons of refrigeration to seven large government buildings. This is piped via a two-mile underground tunnel containing about 600,000 gallons of 40°F. chilled water which is circulated at a rate of 26,400 gpm.

Under the prime contract of Standard Engineering of Washington, D. C., Inc., the instrumentation was installed by Johnson Service Co., to plans drawn up by Consulting Engineer Guy B. Panero.

When you need air conditioning for human comfort or industrial processing requirements, there is a Taylor system that will ensure years of dependable, trouble-free performance. See your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester 1, N. Y., or Toronto, Ontario.

For Vision . . . Ingenuity . . . Dependability in solving your process control problems.

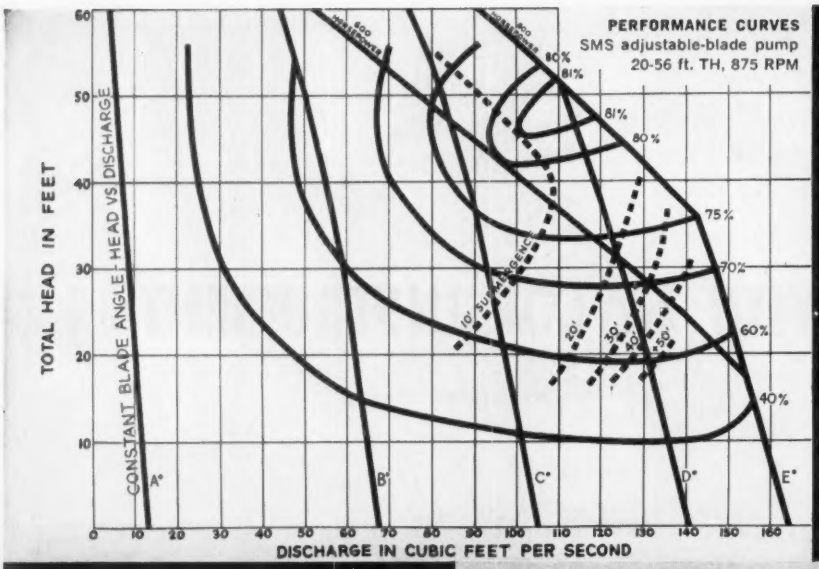


One of the four Compressor Transmitter panels at the Capitol Power Plant. Taylor Potentiometer Transmitters are used to obtain differential chilled water temperatures. Temperature and flow readings are transmitted to the Master Panel (*shown at left*) by TRANSVERTER* Transmitters. These transmitters have a wide range—from 10% to 100% of flow —and measure with an accuracy of ±1% of flow.

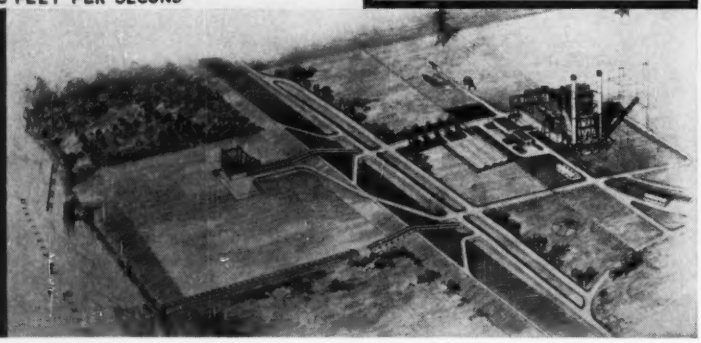
*Trade-Mark

MEAN ACCURACY FIRST

For more facts circle 222 on Reader Service Card, p 100



Performance curves of the SMS adjustable-blade axial flow pumps for Willow Glen illustrate their extreme flexibility. Pump operation is not restricted to a single head-discharge curve as is the case with fixed-blade pumps, but provides any discharge and head combination within the limits of motor horsepower and proper submergence.

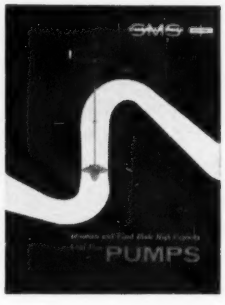


Stone & Webster Engineering Corp. is designing and constructing the Willow Glen Plant at St. Gabriel, La. on the Mississippi River for Gulf States Utilities Co.

Flexibility and efficiency make SMS adjustable-blade pumps choice for Willow Glen

Two 30-inch SMS adjustable-blade axial flow pumps will be installed to provide condenser water for Unit #1 at the new Willow Glen Power Station. To meet the requirements at minimum river level, and with water temperatures that vary between 39°F and 90°F, the pumps are designed to deliver a total of 76,000 gpm against a 54-foot total head.

Extreme variation of suction pool elevation and the flexible condenser operation required for this station made adjustable-blade pumps the logical and economical choice. SMS adjustable-blade pumps attain relatively high efficiencies over a wide discharge and head range. This is accomplished by varying the pitch of the impeller blades while the pump is operating at constant speed. This adjustability keeps pumping costs at a minimum by combining low starting torque with high average efficiency.



Pump Bulletin 165 will give you complete information on SMS high capacity axial flow pumps. To get your copy, write to S. Morgan Smith Co., York, Penna.

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED

RESEARCH · DESIGN · HYDRODYNAMICS · ENGINEERING · FABRICATION

More Power To . . .

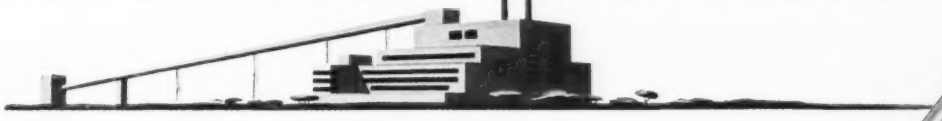
Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

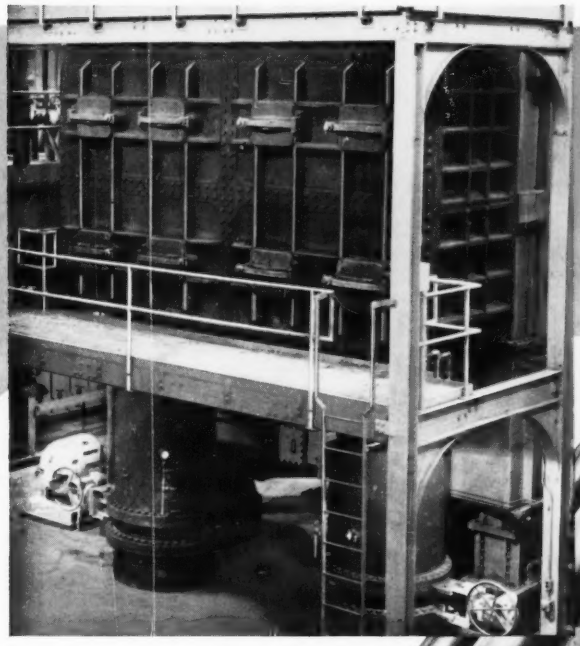
For more facts circle 223 on Reader Service Card, p 100

For more facts circle 224 on Reader Service Card, p 100 →

where trouble-free performance is a matter of pride...

NEW ENGLAND ELECTRIC | SALEM HARBOR STATION





this condenser is tubed with...

HEAT EXCHANGER TUBE

One of the Northeast's most modern and efficient steam power plants, Salem Harbor is being expanded to deliver 300,000 kw to New England's homes and industries.

Scovill Aluminum Brass Heat Exchanger Tube has been specified for installation in condensers serving Salem Harbor's 80,000 kw reheat-type turbo-generators . . . where trouble-free operation is essential in maintaining high efficiency.

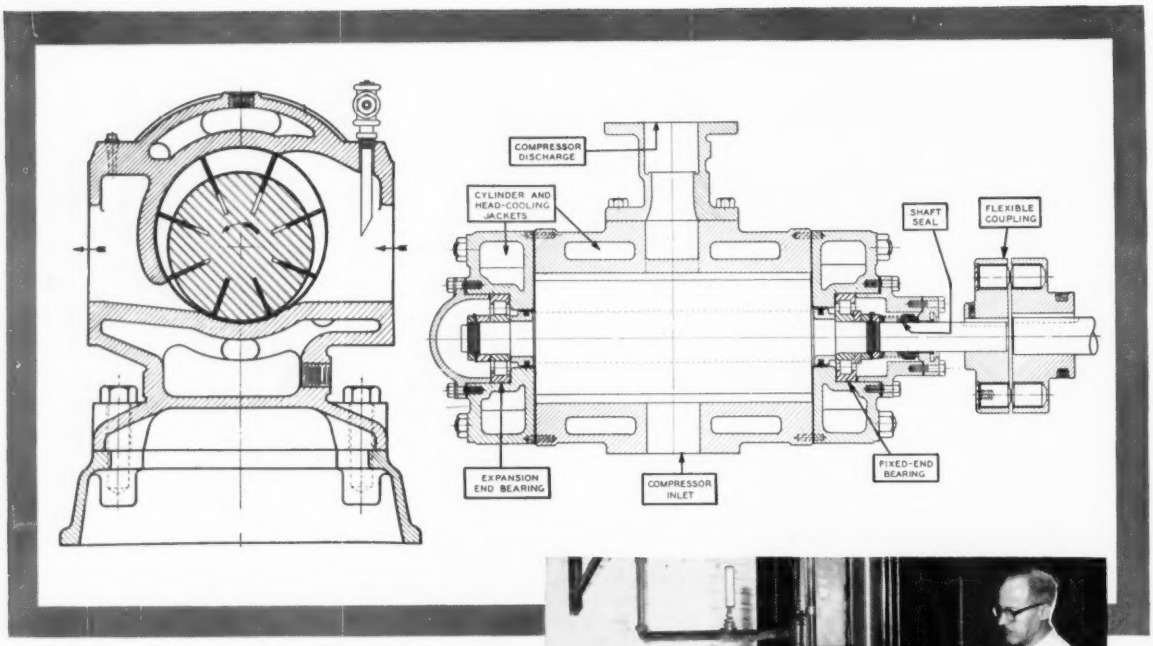
Let Scovill Technical Service and Scovill Heat Exchanger Tube help you, also, to achieve trouble-free performance.

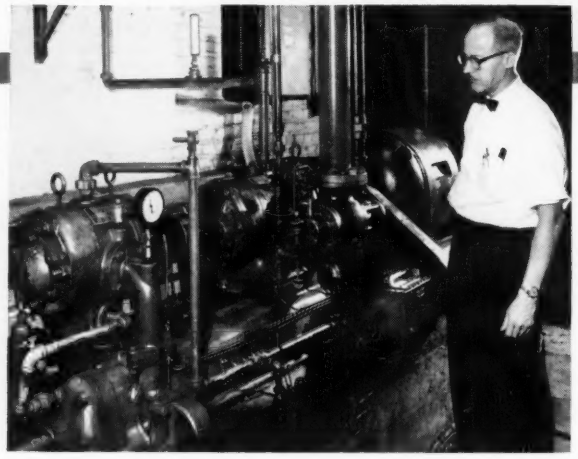
MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

HEAT EXCHANGER TUBE For Applications from Marine to Petrochemical, From Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

162-48





Hard service never affected this Fuller rotary's original output—230 cfm. of air at 90 lb. G., reports Mr. Schott, chief engineer, Thomas C.Wilson, Inc., Long Island City, N.Y.

FULLER ROTARY COMPRESSOR RUNS 13 YEARS WITHOUT DOWNTIME

A Fuller rotary at Thomas C. Wilson, Inc. got its first maintenance shutdown recently, for renewal of roller bearings and rotor vanes—after running without downtime since 1945.

4 years of 24-hour service. The Wilson plant makes tube cleaning equipment, tube expanders and portable pneumatic tools, and so makes heavy daily demands on shop air. For the first four years, three-shift operation kept the Fuller rotary running round the clock. Since 1949, it's been working eight-hour shifts.

Simple design means trouble-free service. Besides bearings, the only moving parts in a Fuller vane-type rotary compressor are the cylinderical rotor and the blades. These compensate for wear automatically. Cylinder head slips off, permitting blade and bearing inspection in a matter of minutes.

Compact and vibration-free. Direct-drive system saves space. Simple, rugged design gives constant service without extensive supervision. Thus, Fuller rotaries can be installed out-of-the-way—on upper floor, on balconies, in basement corners, using low-cost, light-weight foundations.

1189
C-340

Visit Booth 513
Plant Maintenance and Engineering Show
January 26-29,
Cleveland, Ohio

Write today for detailed information on the full line of Fuller rotary compressors for in-plant services, gas gathering, and industrial refrigeration.

FULLER COMPANY GENERAL AMERICAN TRADE MARK

FULLER COMPANY
126 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Birmingham • Chicago • Kansas City • Los Angeles • New York • San Francisco • Seattle

Fuller
....pioneers in harnessing AIR

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

For more facts circle 225 on Reader Service Card, p 100

A gauge glass installed...and two more on the shelf

Make short work of gauge glass replacement—when the replacement is as near as your stockroom shelves. You'll cut down time.

Take *three* gauge glasses the next time you order from your distributor. That gives you *one* for the gauge right away, a *second* for regular replacement, a *third* to cover special emergencies.

And here's another tip—don't rely on any old type gauge glass. Insist on regular replacement with PYREX®, CORNING®, or MACBETH® to avoid trouble.

These gauge glasses last longer—because they're harder to break! They stand up better to just about every clouding hazard. They easily resist high temperatures and high pressures.

One of these brands is just right for your gauge. Get some from your regular mill supply dealer. And remember—ask for *three* for each gauge!

(Corning makes sight glasses, too—from tough PYREX brand glass. Use them whenever you must see what's going on inside your processing equipment. Your distributor has them.)

Corning means research in Glass **CORNING GLASS WORKS, Corning, N. Y.**

For more facts circle 226 on Reader Service Card, p 100

Dyna-V is entirely new. In every detail, Dyna-V has been engineered to take advantage of today's great improvements in belt materials and metal alloys—resulting in V-belt drives that are sensationally compact.

Dyna-V is capable of handling up to three times as much horsepower in a given space. Dyna-V opens vast new possibilities for better, more economical machine design. And, in most instances *Dyna-V costs less!*

An entirely new high in strength and horsepower capability is packed into Dyna-V Belts. Cross section dimensions are substantially reduced—top width is much narrower. Dyna-V Sheaves are designed for these belts. Narrower grooves reduce face width—and weight. Costs are lowered. Smaller diameter sheaves and shorter center distances multiply savings.

Increased sheave strength for increased capacity is obtained through changes in design that utilize the full benefit of modern improvements in alloy metals. Dodge is noted for the superiority of its semisteel castings, to which now have been added ductile iron castings produced with the most modern electric furnace facilities.

Dyna-V Sheaves are equipped with Taper-Lock Bushings. The superiority of this mounting, patented by Dodge, is widely recognized. Taper-Lock's holding power is terriffic, yet it is "easy on, easy off." And Taper-Lock Bushings provide the additional advantage of interchangeability.

The benefits of Dyna-V go beyond compactness and initial low cost. Smaller sheaves reduce shaft overhang—increase bearing life. The dimensional stability of Dyna-V Belts (which are heat resistant, oil resistant, static conducting) solves the problem of belt matching. Every belt carries its full share of the load. The crowned top of Dyna-V Belts is a new concept in belt design. Combined with proved concave sidewall construction, it insures perfectly even load distribution between belt and sheave.

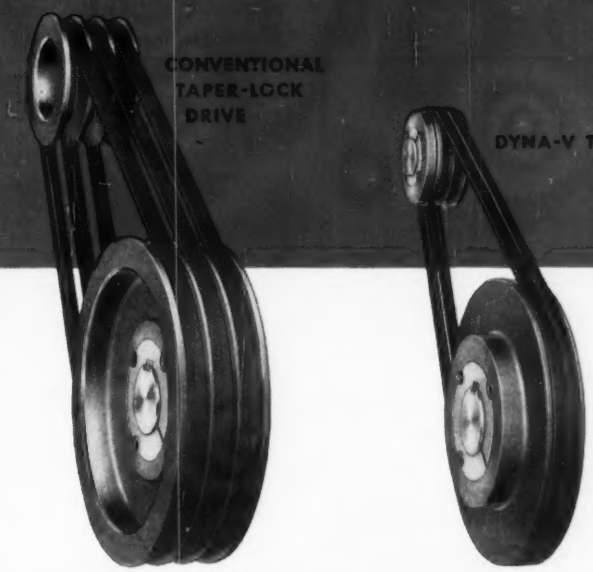
A complete bulletin on Dyna-V, including drive selection tables, will soon be ready. If you want one of the first copies, write us at once. Or see your local Dodge Distributor.

DODGE MANUFACTURING CORPORATION
3200 Union Street, Mishawaka, Indiana

DODGE
of Mishawaka, Ind.

DODGE

Dyna V



Dyna-V Drives for capacities up to 50 horsepower are now available from stock, using the new belt cross section, "3V," and Dyna-V Taper-Lock Sheaves to match.

Dyna-V Drives for capacities up to 200 horsepower, using "5V" belts and sheaves will be available from stock in March. Larger sizes up to 1500 hp, with "8V" belts and sheaves, can be furnished on order.

COMPARISON, ILLUSTRATED ABOVE — 3 HP, 1750 RPM, 2.41 TO 1 RATIO

	BELTS		SHEAVES			CENTER DIS-TANCE	HP	WEIGHT (LBS.)	COST	
	Number	Size	O.D. Driver	O.D. Driven	Width				Per hp	Per Drive
CONVENTIONAL TAPER-LOCK DRIVE	3	A42S	4.15"	8.95"	2½"	12.3"	4.62	24.7	$5.91	$27.38
DYNA-V TAPER-LOCK DRIVE	2	3V400	3.35"	8.00"	1$\frac{3}{32}$"	10.8"	5.0	18.0	$4.50	$22.50
% SAVING *Savings vary with different sized drives*			19%	10%	56%	12%	+	27%	23.8%	17.8%

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

For more facts circle 227 on Reader Service Card, p 100

MARTIN
ORLANDO

one of the top ten plants of the year

Architect-Engineer: Connell, Pierce, Garland & Friedman, Miami, Fla.; *General Contractor:* Thompson & Street Co., Charlotte, N. C.; *Steam Generating Equipment:* Power & Combustion, Inc., Baltimore, Md.; *Mechanical Contractor:* William H. Singleton Co., Arlington, Va.

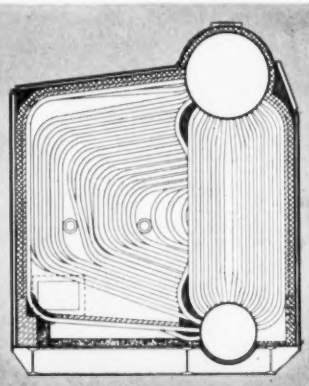
MARTIN-Orlando
dedicated to the service of America

A new type of facility — a complete research, development and production center for guided missiles, electronics and small weapon systems — Martin-Orlando is extremely functional and represents the most modern, scientific concepts of layout and design that man can devise.

selected KEELER dk package steam generators for their efficiency and compactness

Two Keeler DK's supply steam for the entire process, heat, hot water and air conditioning load of this ultra modern Martin plant. The entire facility, consisting of four main buildings with approximately 500,000 square feet of space, is located on a 6700-acre site near Orlando, Florida. The steam generators are supplying the steam requirements with capacity to spare and provision for future needs.

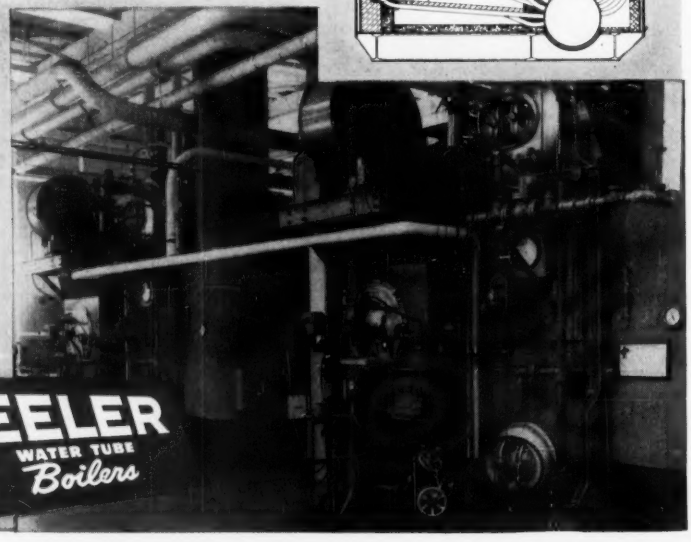
Each of the DK units has a 28,000 lb/hr capacity and is designed for 200 psi safe working pressure. Both are oil fired and operated at 125 psig — either unit capable of carrying the full load.



This is the third Martin installation of Keeler DK Package Steam Generators . . . Martin-Denver has two 465-hp units and Martin-Baltimore has a 450-hp unit.

Multi-purpose Keeler DK's are made in 24 sizes for gas, oil or combination firing, in capacities up to 60,000 lb/hr, standard design pressures to 600 psig. The unit is a completely steel encased package, with water cooled and insulated furnace sides, roof, floor, burner and target walls.

The DK features tube-to-tube construction on both sides of the furnace, providing the maximum amount of radiant heating surface. Uniform diameter water tubes facilitate cleaning or replacing — a truly low first cost, low operating cost package steam generator. *Write for full data and specifications.*

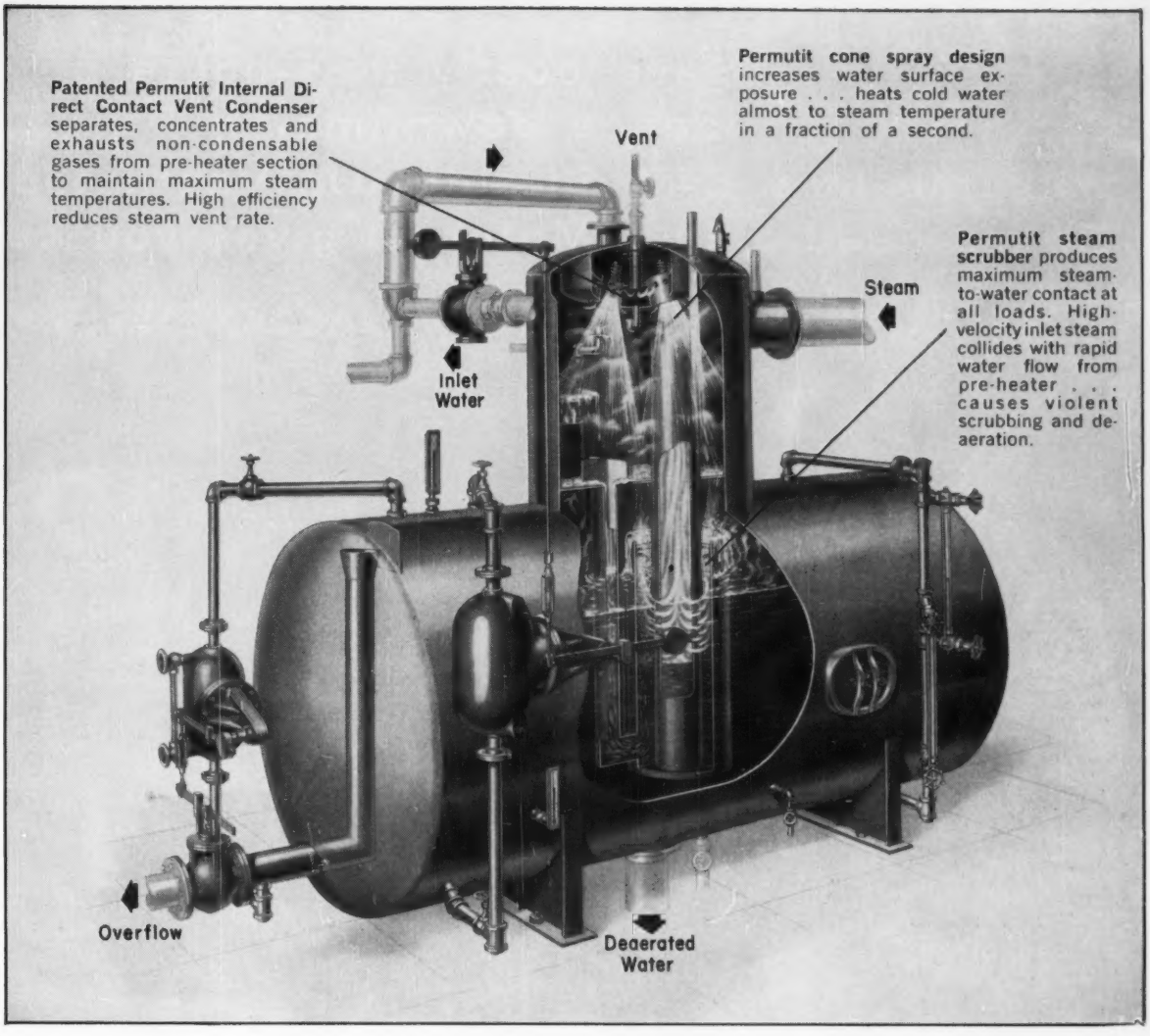


— ESTABLISHED 1864 —

The Seal of Quality in Water Tube Steam Generators

E. KEELER COMPANY
200-300 West Street
Williamsport, Penna.

KEELER WATER TUBE Boilers


Patented Permutit Internal Direct Contact Vent Condenser separates, concentrates and exhausts non-condensable gases from pre-heater section to maintain maximum steam temperatures. High efficiency reduces steam vent rate.
Permutit cone spray design increases water surface exposure . . . heats cold water almost to steam temperature in a fraction of a second.
Vent
Steam
Permutit steam scrubber produces maximum steam-to-water contact at all loads. High-velocity inlet steam collides with rapid water flow from pre-heater . . . causes violent scrubbing and de-aeration.
Inlet Water
Overflow
Deaerated Water

New package deaerators guarantee less than 0.005 ml/L of oxygen at all loads

Permutit Type B Deaerators are available in horizontal and vertical designs with capacities up to 150,000 lbs./hr. All sizes reduce oxygen to the lowest measurable amount . . . at all loads. All sizes offer low head-room dimensions and simplicity of design to reduce maintenance. No trays to be removed or cleaned. Tubeless internal vent condenser eliminates tube cleaning or replacement. All units certified ASME Code.

Package sizes for fast shipment

Three horizontal sizes (see illustration) are available from stock: 30,000, 50,000 and 70,000 lbs./hr Complete drawings, installation and operating instructions are available on order. Shipments normally made 2 to 3 weeks from receipt of order. All internals, including sprays, are completely assembled. Float-cage and gauge-glass piping and valves are pre-fitted to simplify installation.

Capacities up to 3,000,000 lbs./hr.

Type A Deaerators are designed for larger capacities from 150,000 to 3,000,000 lbs./hr. Vertical and horizontal arrangements available to meet specific space requirements. The basic simplicity and low maintenance cost of Permutit Deaerators have been proved by over 1100 units in use . . . many in operation as long as 19 years in leading industrial and public power plants.

Other Permutit boiler feedwater equipment: aerators, chemical feeders, precipitators, pressure or gravity filters, zeolite and hot-process softeners, dealkalizers, demineralizers, vacuum deaerators, control cubicles, CO_2 analyzers, blow-off equipment. For details, write: The Permutit Company, Dept. PO-19, 50 West 44th St., New York 36, N. Y.

PERMUTIT.

rhymes with "compute it"

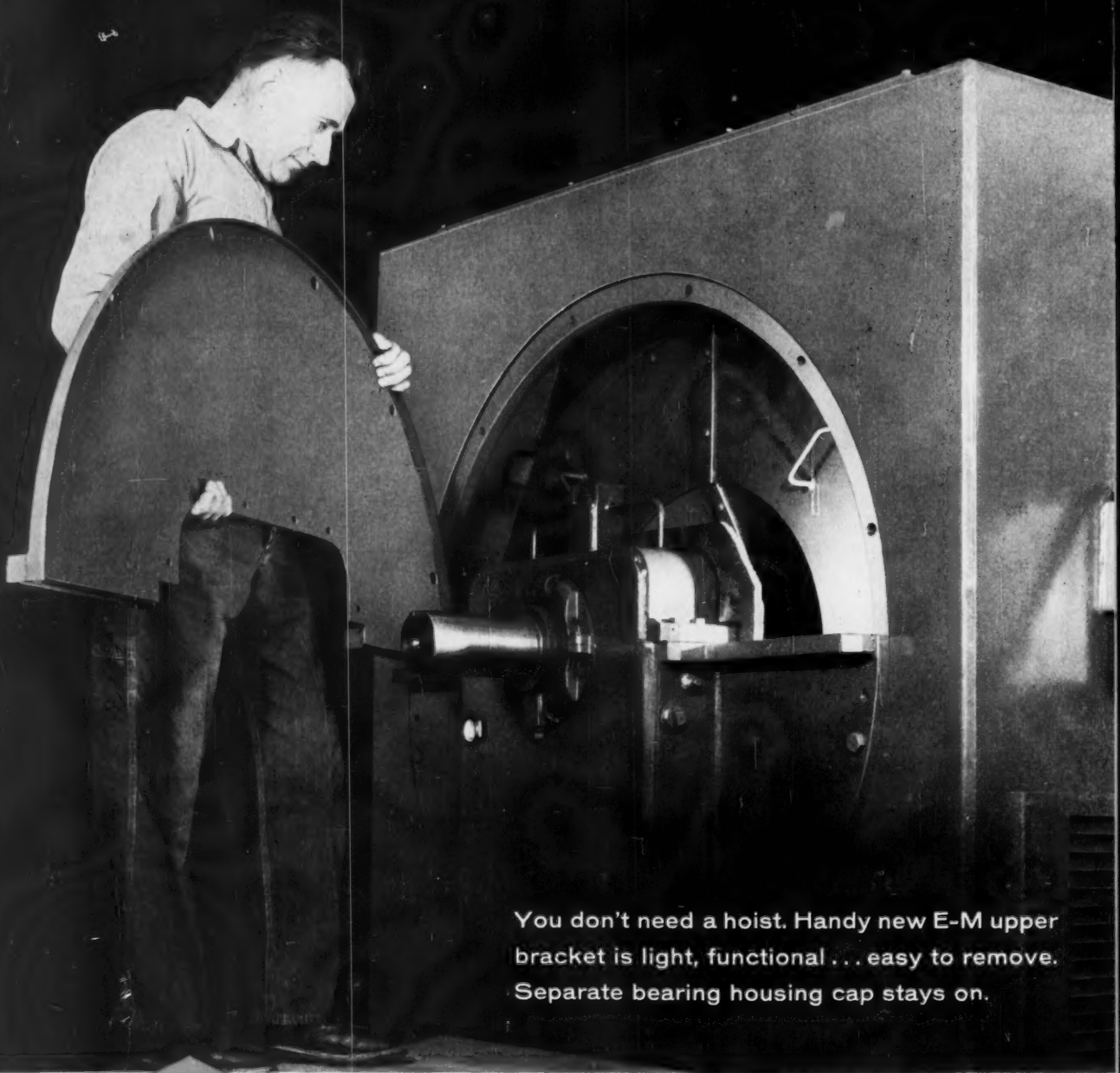
A DIVISION OF PFAUDLER PERMUTIT INC.

Water Conditioning
Ion Exchange • Industrial Waste Treatment

For more facts circle 229 on Reader Service Card, p 100

NOW Save costly man-hours, reduce downtime with the new E-M Straight-Up-Ventilated Boiler Feed Pump Motor. It gives you . . .

Quick and Easy Access



You don't need a hoist. Handy new E-M upper bracket is light, functional . . . easy to remove. Separate bearing housing cap stays on.

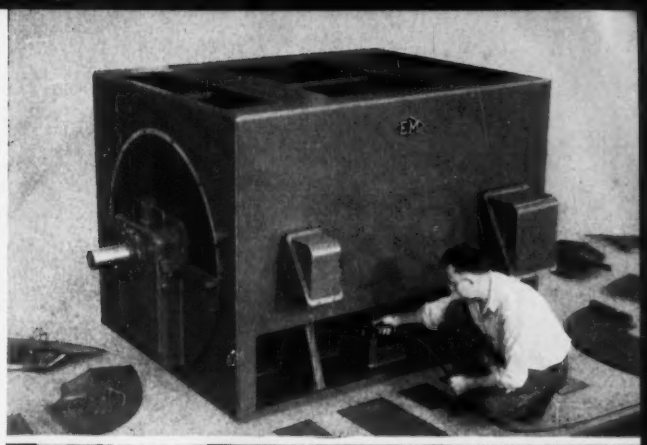
E-M 1300-TPA-2158

ELECTRIC MACHINERY

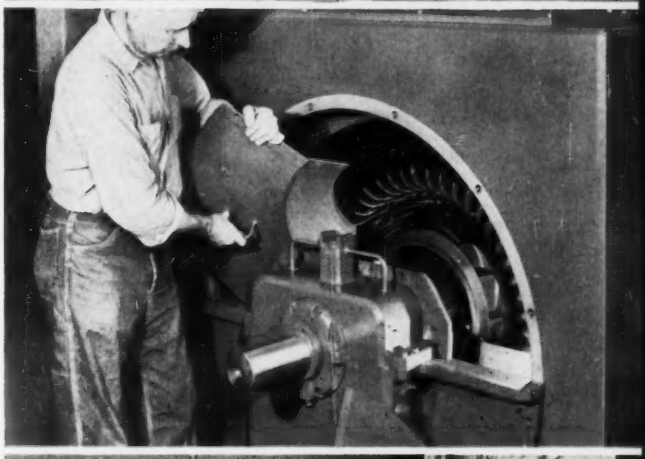
Builders of the new pump motor

For more facts circle 230 on Reader Service Card, p 100

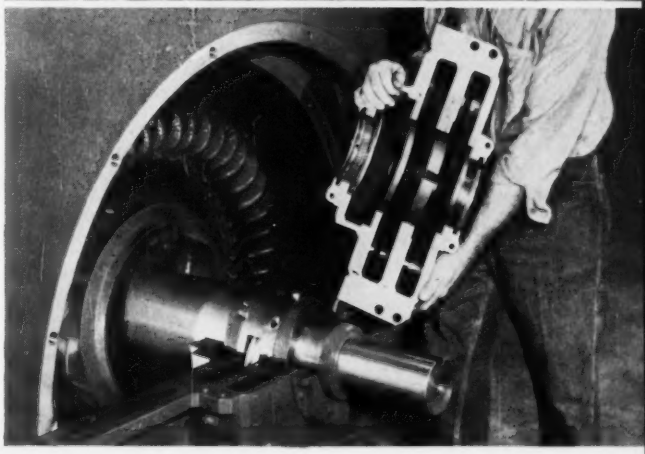
It's easy to remove louvers —just unbolt, lift off. Access plates let you clean thoroughly behind stator core.



Coils are readily checked for condition and cleanliness. Four-section air baffle comes out easily without taking off lower bearing bracket.

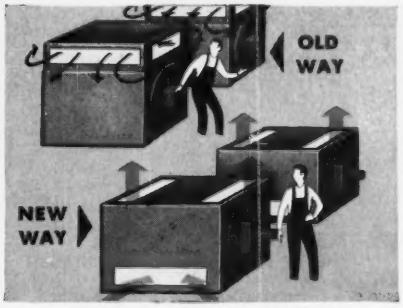


Just lift the cap to inspect bearings. Raise the rotor shaft to roll out the lower bearing half.

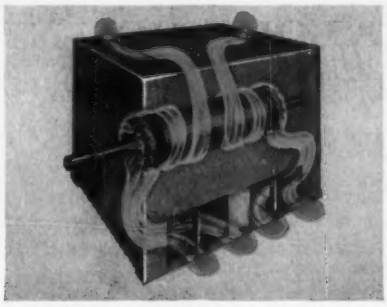


Learn more about the motor that's a pleasure to service. Ask your nearby E-M Sales Engineer and write to the factory for your copy of illustrated brochure No. 1134-P.

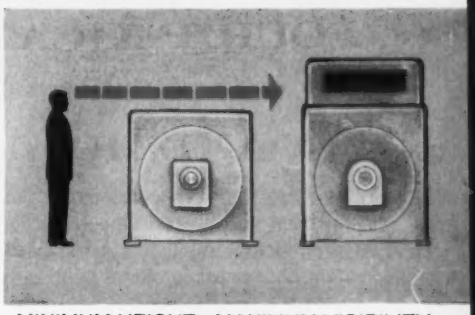
More of the MANY BIG DIFFERENCES that MAKE THE DIFFERENCE



STRAIGHT-UP-VENTILATION



AIR-FLOW ACOUSTICAL CONTROL



MINIMUM HEIGHT—MAXIMUM VISIBILITY

MFG. COMPANY MINNEAPOLIS 13, MINNESOTA

that performs as well on the job as on the test stand

In Bulletin No. 6050 on P-K forced boiler water heat exchangers complete capacity tables are provided, grouped by temperature ranges. Pressure drop is shown for each capacity. Dimensional data supplied

Catalog No. 19 covers P-K storage water heaters in plain steel, copper-lined, copper silicon, Pre-Krete lined, clad and galvanized. In addition to tabular data on capacities, weight and dimensions, this book carries a handy conversion table to determine capacities of heating sections with various temperature ranges and steam pressures.

Catalog No. 202 describes P-K instantaneous water heaters. Contains capacity tables covering two, four and six pass design. Tables are grouped by steam pressures ranging from 0 to 100 psi. Inlet and outlet temperatures are listed with hot water capacities.

In this P-K Bulletin No. 303-A, covering convertors for forced circulation water heating systems, capacity tables include the usual ranges for standard water heating systems. Also included are general ranges for radiant heating systems.

FOUR P-K CATALOGS YOU NEED

when specifying any hot water system...

AND HOW TO GET YOUR COPIES

With these four P-K catalogs on your desk you have installation and performance data, conveniently tabulated on instantaneous hot water heaters, storage water heaters, convertors for water heating systems and forced boiler water heat exchangers. Just write us for P-K heating equipment file #126 and we'll send you the set. The Patterson-Kelley Co., Inc., 2501 Warren Street, East Stroudsburg, Pa.

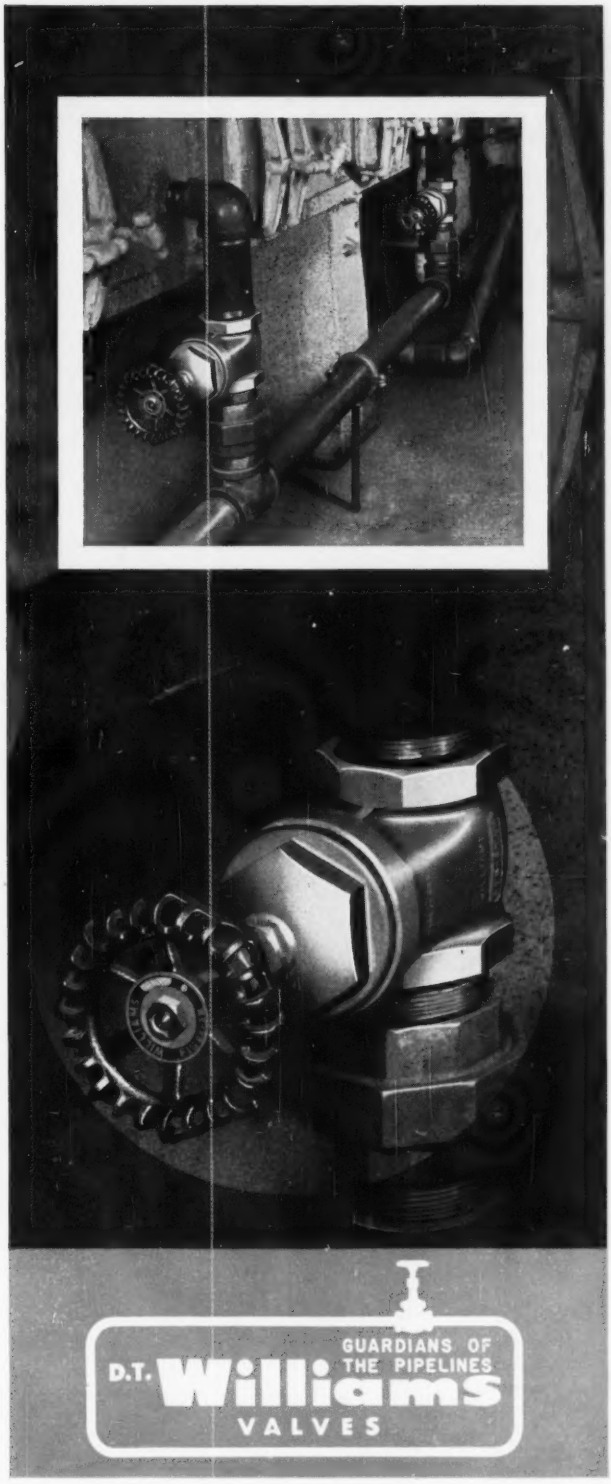
6

Patterson Kelley

Water Heater Division

storage water heaters • instantaneous heaters • convertors • water to water exchangers

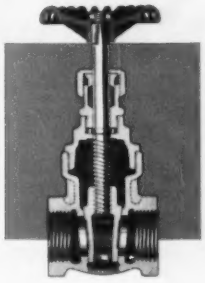
For more facts circle 231 on Reader Service Card, p 100



FULL FLOW POSITIVE SHUT-OFF

D. T. WILLIAMS VALVES
at Jones-Dabney Co., Division of
Devoe & Raynolds Co., Inc.

Handling a hazardous liquid like paint thinner is a tricky job at best. Safety control measures are vital. Here are two of the many dependable Williams gate valves used in a large installation just completed for Jones-Dabney Co., Detroit, Michigan, by the Diebold Service Co. The piping shown carries the flow of thinner from storage tanks on the first floor to paint mixing vats on the floor above. Other Williams valves are used at the pump station and on other lines in the plant. Do you have a similar important job?



FEATURES

- D. T. Williams Fed-Stan® bronze gate valves
- 125 pounds pressure
- Full unimpeded flow
- Bronze taper solid disc and integral seat
- Non-rising stem
- Deep stuffing box

SEE YOUR D. T. WILLIAMS DISTRIBUTOR

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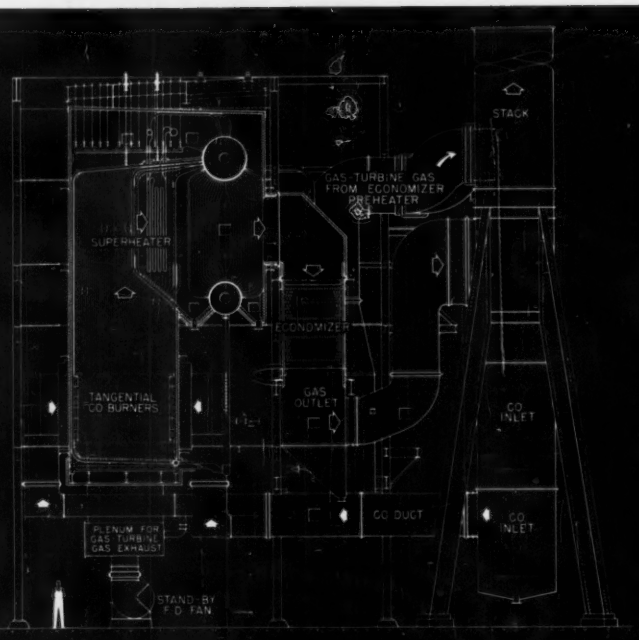
AMERICAN-Standard
DETROIT CONTROLS DIVISION

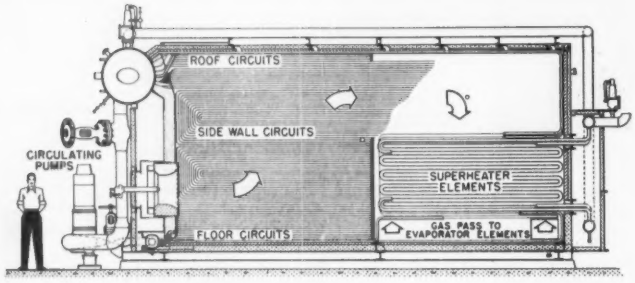
For more facts circle 232 on Reader Service Card, p 100



For refineries

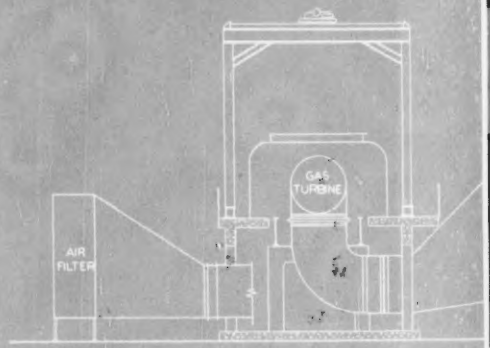
C-E Vertical Unit Boiler, Type VU-40 CO – tangentially fired boilers to efficiently utilize energy potential in hard-to-burn waste catalyst regenerator gas. Illustrated is an installation at a Gulf Coast refinery. It combines a catalyst regenerator, two gas turbine-driven compressors, two CO boilers, and separate turbine exhaust-gas feedwater heaters located between the boilers. Available in a wide range of sizes for any quantity of catalyst regenerator gas and for any steam capacity, CO Boilers by C-E have been in service more than three years.

Special boilers for special



For diverse industrials

C-E Package Boiler, Type PCC—new, completely shop-assembled, high performance, Controlled Circulation steam generator. Now in service with capacities to 120,000 lb/hr, it is available with temperatures to 900 F. and pressures to 1,000 psi (or higher if desired). This boiler is especially suitable where maximum capacity, temperature, and pressure are required, yet space is limited. Offers easy handling of rapid load swings and high quality steam production. PCC's in service include the world's highest capacity, highest pressure, and highest temperature package boilers.



C-E builds boilers of virtually all designs and types known in present practice . . . in capacities from less than 10,000 to 4,000,000 or more lb. of steam per hr. It is presently building units that will set new world records for capacity, pressure and temperature.

This vast experience has also been successfully applied to the development of many special designs to utilize waste fuels or to meet unusual steam requirements or space conditions.

A few recent examples of special C-E designs which have successfully met unusual problems are illustrated here. In several cases, this success may be attributed to the utilization of exclusive C-E developments such as controlled circulation or tangential firing.

Whether your requirements call for boilers of unusual characteristics, such as those shown here, or for more conventional standard designs, come to C-E where you'll find the skill, experience, facilities—and desire—to meet your needs *exactly*.

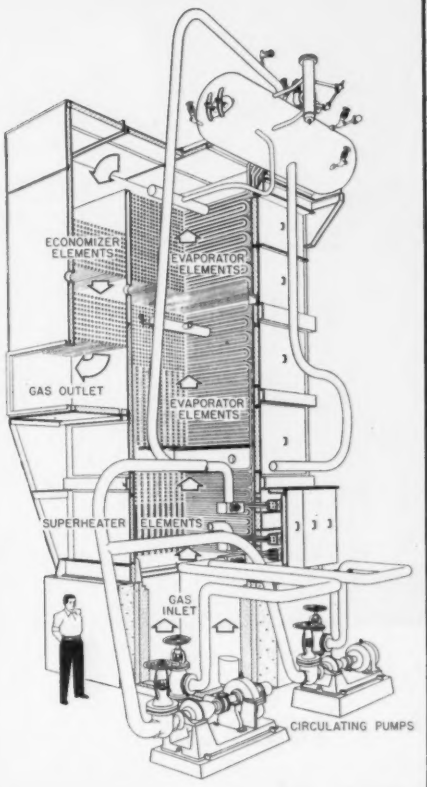
needs—by C-E

For gas turbine installations

C-E Gas Turbine Boiler—waste heat design for economical utilization of gas turbine exhaust sensible heat. Usable in a choice of cycles to obtain fired or unfired heat recovery and steam generation. Illustrated is a combined cycle, two of which are in service at a chemical plant. Here the turbine is followed by a waste heat boiler, multiple-purpose economizers (process and feedwater), and a conventional oil-fired steam generator which uses a portion of the high temperature exhaust gas for combustion air.

For the steel and chemical industries

C-E Package Boiler, Type WCC—a Controlled Circulation design which utilizes waste heat from open hearths or chemical processes. The platen surfaces featured in the first pass permit passage of abrasive or "sticky" gas without erosion or bridging, prolonging boiler life and making the unit easier to clean. Controlled Circulation assures positive control of water to all circuits, permitting a smaller boiler with obvious space-saving advantages. Seven WCC's are now in service; eight others are being erected.



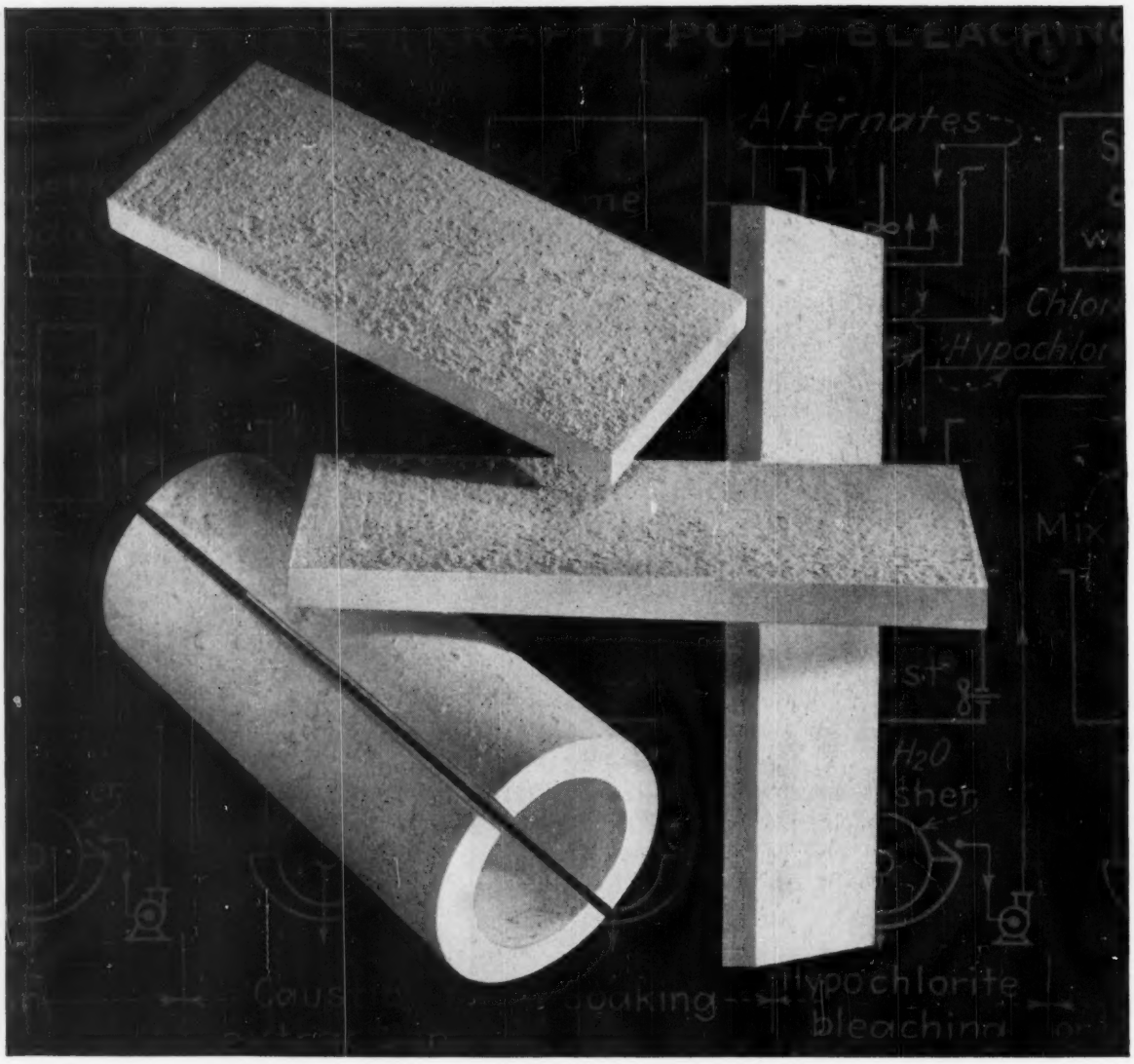
COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

C-195

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more facts circle 233 on Reader Service Card, p 100



For paper pulp refining as in other operations, "K&M" High-Pressure Insulations provide durable, economical heat control.

Your customers get more heat from every ounce of fuel with "K&M" High-Pressure Insulations!

Minimize installation time and costs, and be sure of customer satisfaction. How? With "K&M" High-Pressure Insulations.

Maximum fuel efficiency, minimum fuel costs, and more precise process control—that's what you offer your customers with "K&M" High-Pressure Insulations. They last the lifetime of the equipment. Tame temperatures of up to 1900° F. Withstand temperature changes, vibration, and moisture.

The ease of handling and installing of "K&M" High-Pressure Insulations makes your job quicker and more profitable.

Write to us today for a free brochure on "K&M" High-Pressure Insulations.

For temperatures up to 1900° F., use "K&M" Hy-Temp Combination—diatomaceous silica overlaid with "K&M" "Featherweight" 85% Magnesia. Staggered joints prevent heat loss from expansion-caused openings.

For temperatures up to 1350° F., use "K&M" Kaytherm—hydrous calcium silicate bonded with asbestos fibers. Important for petroleum and power applications.

For temperatures up to 600° F., use "K&M" "Featherweight" 85% Magnesia—a basic carbonate of magnesia mixed with asbestos fibers.

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

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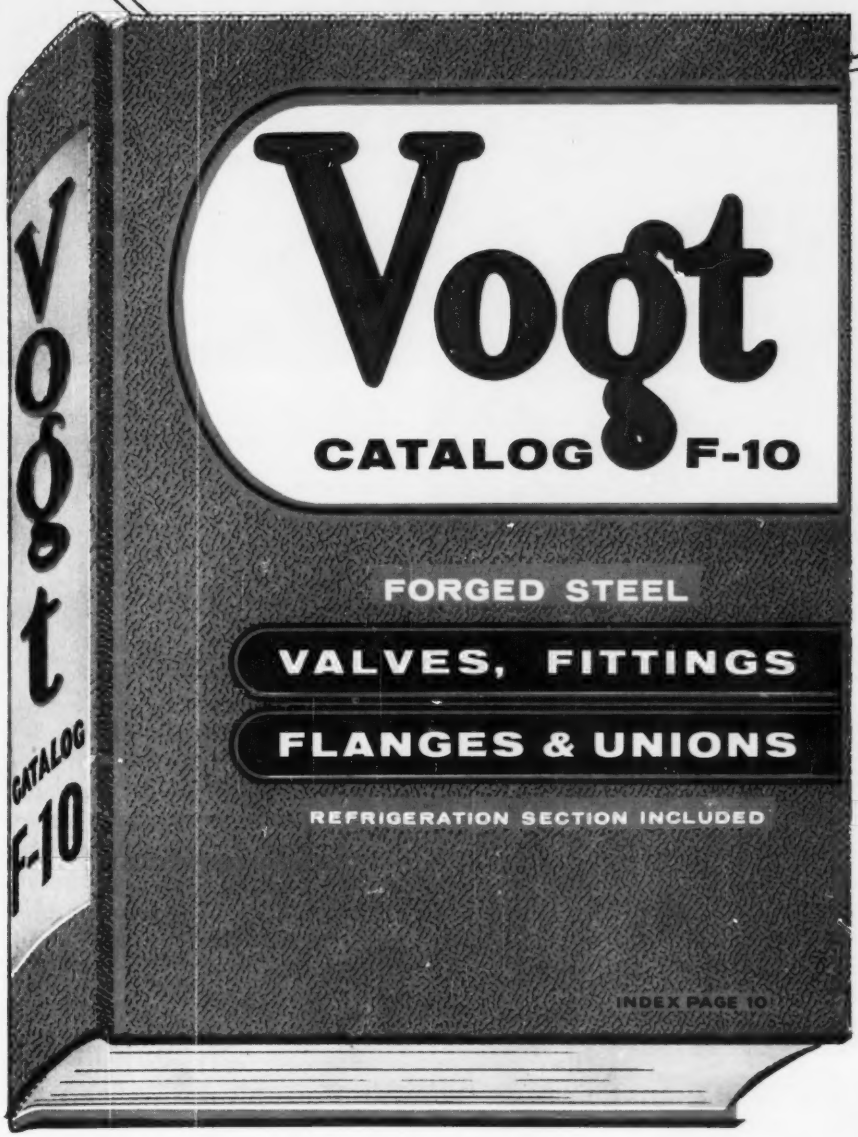
Presenting a NEW

Vogt Blue Book



Catalog F-10 is the one source for the most complete line of forged steel valves, fittings, flanges, and unions available to industry. Its 432 thumb indexed pages feature new types and trims to best meet severe fluid and gas handling duties at all temperatures and pressures.

A copy of this new catalog is available to you. Please send your request, on your company letterhead, to Dept. 24A-FP.

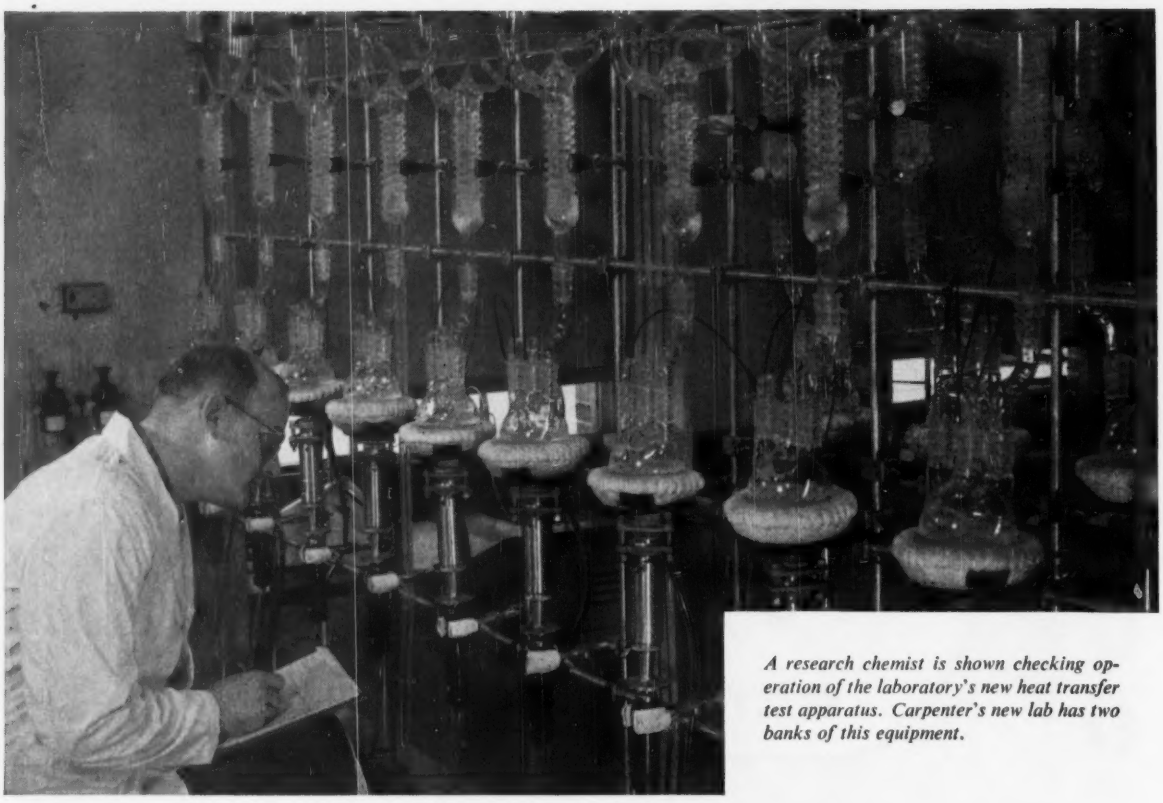
Leading petroleum refineries, petro-chemical and chemical plants, and power plants get top performance with safety from Vogt forged steel valves, fittings, flanges, and unions.

OTHER VOGT PRODUCTS:
Steam Generators, Petroleum Refinery and Chemical Plant Equipment, Heat Exchangers, Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE COMPANY
LOUISVILLE, KENTUCKY

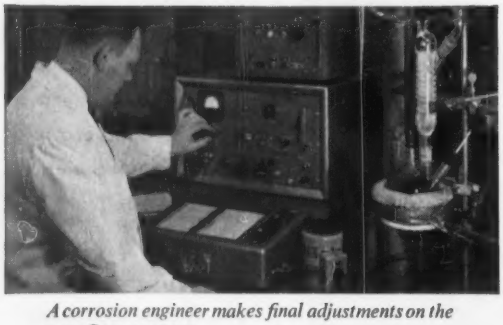
SALES OFFICES
New York, Chicago, Cleveland, Dallas, Camden, N.J., St. Louis, Charleston, W.Va., Cincinnati

For more facts circle 235 on Reader Service Card, p 100

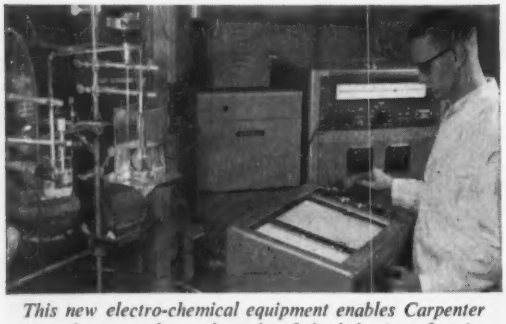


A research chemist is shown checking operation of the laboratory's new heat transfer test apparatus. Carpenter's new lab has two banks of this equipment.

Carpenter's new corrosion laboratory can predict stainless tubing performance on your job



A corrosion engineer makes final adjustments on the new Corrosometer.

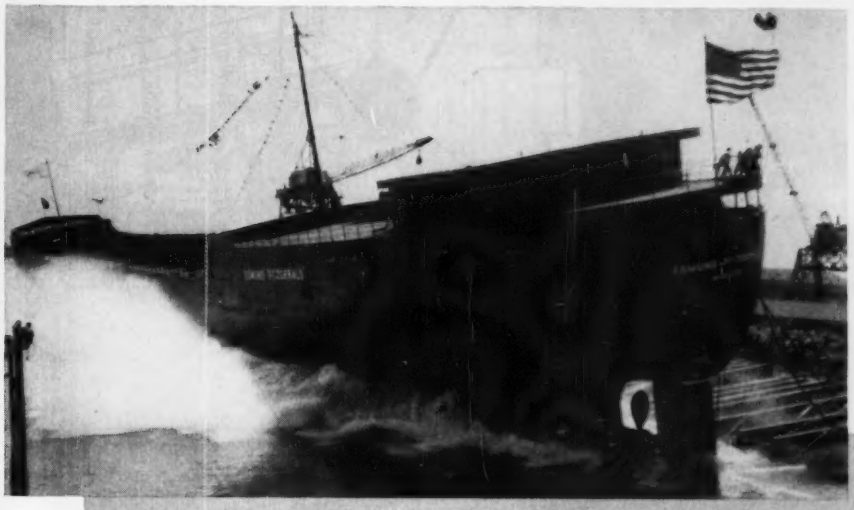


This new electro-chemical equipment enables Carpenter to make more thorough study of the behavior of stainless steels and thus gather more background for the development of new and improved alloys.

This new laboratory is considered the largest and best equipped of its kind among companies producing specialty steel exclusively. Heat transfer apparatus, Corrosometer, multi-sample tester, electro-chemical equipment, high pressure, elevated temperature corrosion testing, and stress corrosion cracking equipment give Carpenter the facilities to help solve your corrosion problems and select the right material for any of your needs. Carpenter . . . first in corrosion research . . . first in corrosion control . . . first in stainless tubing and pipe economy. Authorized distributors in over 40 cities, coast to coast. Or write to The Carpenter Steel Company, Alloy Tube Division, Union, N.J.

your master key to cost-saving corrosion control

Stainless Tubing & Pipe



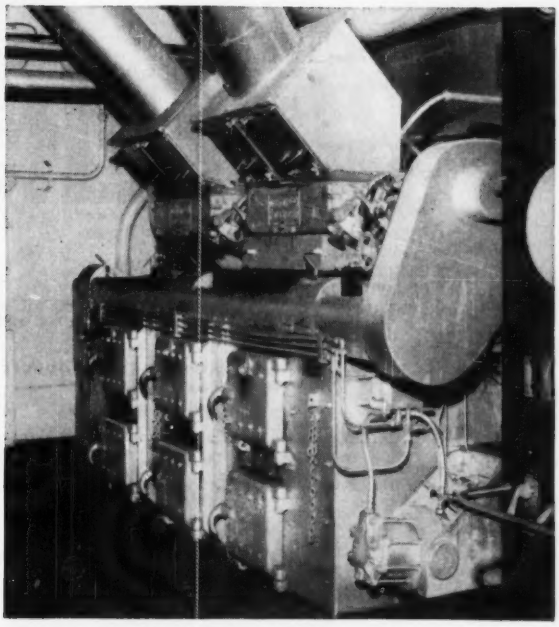
Launching of the Edmund Fitzgerald—largest ship on the Great Lakes. Length 729 ft., beam 75 ft., depth 39 ft., Ore cargo capacity 26,000 gross tons. Owner, The Northwestern Mutual Life Insurance Co. Builder, Great Lakes Engineering Works, at its River Rouge, Mich., yard. Charterer, Columbia Transportation Division of Oglebay Norton Co.

(Wide World Photo)

SS EDMUND FITZGERALD . . .

the 61st Ship equipped with

DETROIT STOKERS



One of 2 Detroit RotoStokers Type CC firing 2 Combustion Engineering Co. bent tube marine boilers in the Fitzgerald. Each boiler is rated at 32,750 pounds steam per hour MCR—36,000 pounds per hour peak. Operating pressure is 470 psig. Total steam temperature is 755°F. Design is for 12,350 BTU bituminous coal with 11.9% ash.

The Str. Edmund Fitzgerald, with Detroit RotoStokers Type CC (continuous cleaning), is the 61st ship in 10 of the Great Lakes fleets to be equipped with Detroit Stokers.

These ships burn coal because it is the most economical fuel . . . burn it on Detroit Stokers because of their high efficiency and dependable operation.

Dependability is important anywhere . . . doubly so on ships where failure at a critical moment would be serious. Stoker efficiency is a first concern of cost conscious ships' crews who compete for operating economy records.

An additional advantage in ship as well as other installations is the fact that the Detroit RotoStoker and the RotoStoker CC can be installed for firing-floor ash discharge if desired, avoiding the use of basement or hold space for ash bunkers.

Efficiency, flexibility, low upkeep and high availability of Detroit Stokers is well known wherever coal is burned.

For the same kind of superior stoker service and economy that was chosen for this giant steamship, let us survey your plant and give you recommendations—without obligation.

DETROIT STOKER COMPANY

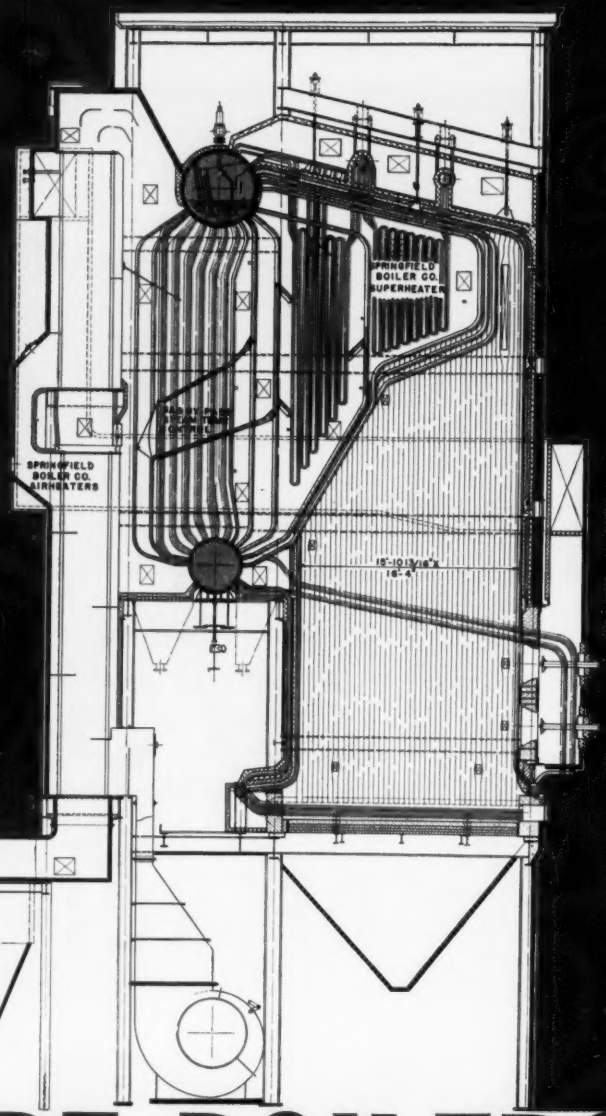
MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

For more facts circle 237 on Reader Service Card, p 100

For more facts circle 238 on Reader Service Card, p 100 →

FIELD-ERECTED
WATER-TUBE BOILERS



Cleaver-Brooks
PRESENTS

SPRINGFIELD

WATER-TUBE BOILERS

Cleaver-Brooks, originator and largest producer of packaged boilers, announces the acquisition of Springfield Boiler Co. — designers and manufacturers of water-tube boilers.

The purchase of Springfield Boiler Co. is a significant step in Cleaver-Brooks continuing program of progress and expansion. The product line now includes both fire-tube and water-tube boilers in a wide range of capacities from 500 to 300,000 lb./hr.

Springfield water-tube boilers are known through more than 68 years of use by leading industries, utilities, municipalities and institutions.

CLEAVER-BROOKS COMPANY, MILWAUKEE, WIS.

Cleaver Brooks®

ORIGINATOR AND LARGEST PRODUCER
OF PACKAGED BOILERS

PACKAGED WATER-TUBE BOILERS

You asked for it...

You'll find new values in this first issue of POWER's *76th year—advances designed to make your magazine even more useful and readable.*

Those are the words with which I started last January's editorial and I'm pleased to be able to repeat them as we start our 77th year. Then, as now, I was talking about the results of a critical re-examination of POWER's content and format.

The first results, introduced in January 1958, included the new *Today's Development* reports, introduction of the annual Plant Design issue, and format changes to transmit more information, faster and easier.

Now, in January 1959, you see further results of our critical re-examination of POWER's editorial service: new departments and improvements in familiar ones, plus a radical re-arrangement of POWER's makeup that brings you the convenience of *consecutive reading.*

Recently we've noticed that the No. 1 suggestion from POWER readers has concerned their dislike for "runover." This was a tough one to tackle, but we think we have it licked now. You'll find, as you read through the pages following this editorial, that there won't be a single item "continued on page 228." This change was made with you, the reader, in mind. To accomplish it we had to shift some advertising around, but we're sure you will find yourself getting more out of POWER now than ever before and that, of course, is our aim.

In the interests of quickly gaining familiarity with the new structure, let me outline it for you here and suggest that you then "scout" the entire issue quickly before you settle down to read the items of greatest interest to you.

In its accustomed position as the first major block of editorial material, you'll find the Design and Equipment Application section. No startling change here—but all articles are completely self-contained, without "continuations."

The Plant Maintenance and Management section, formerly next in sequence, now appears in another completely self-contained unit at the back of the magazine, just ahead of the classified ads.

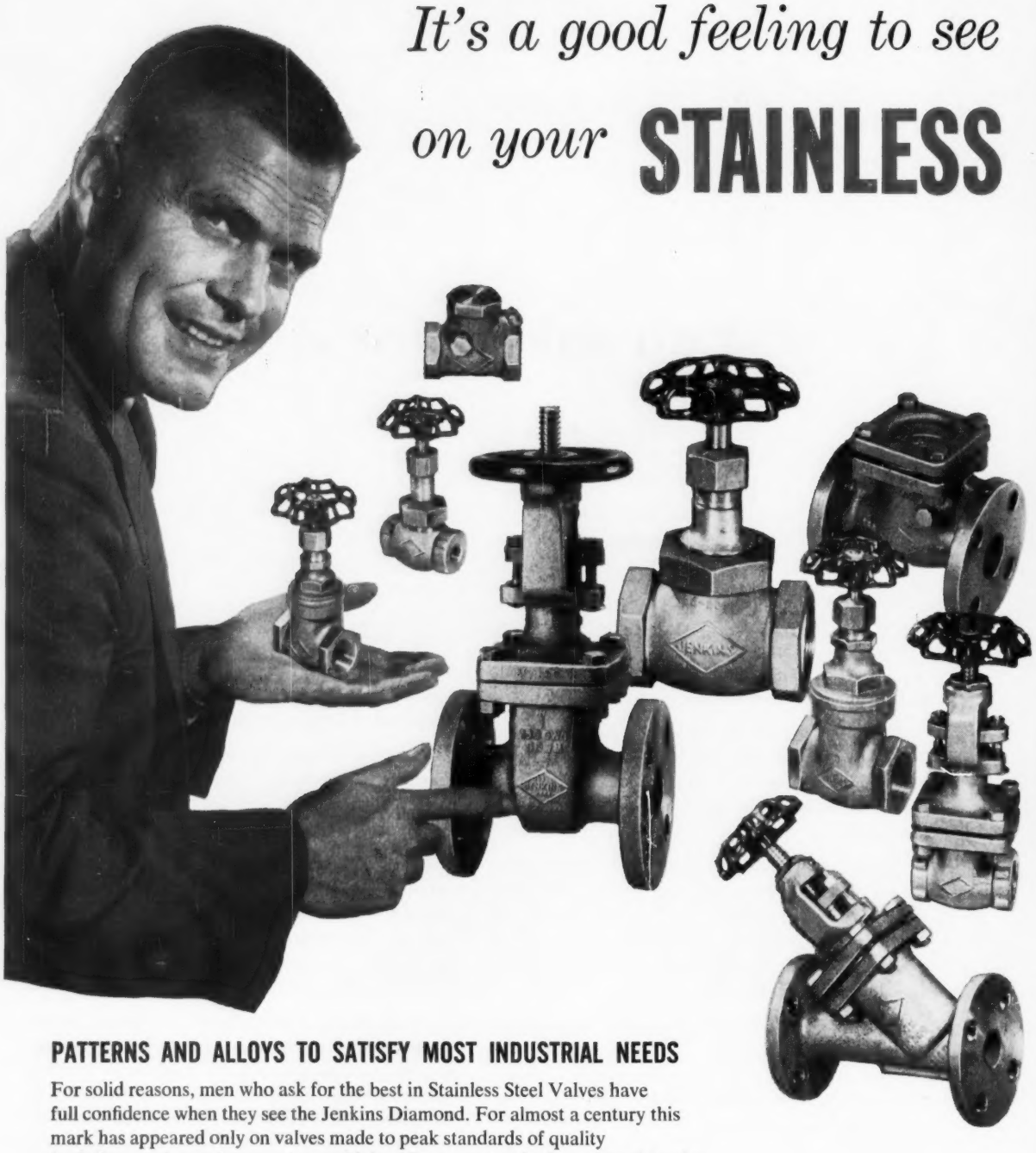
Between these two feature sections, of special interest to particular groups of subscribers, you'll find the service departments, with their wide appeal for all. And here you'll see the greatest change from past practice. Now each department starts and ends in consecutive pages, without a break.

When you've had a chance to become accustomed to this new makeup, and to test the greater reading ease and convenience it offers, let me hear from you (use handy card, p 100). Bouquets or brickbats, I'll welcome your frank comments.

Only with your continued helpful suggestions can we make further progress in tailoring POWER to your changing needs and interests. As a paid subscriber, you are, in a very real sense, a partner in this engineering editorial service. Give us the benefit of your ideas on ways to make it ever more useful in today's dynamic and challenging world.

It's a good feeling to see

on your **STAINLESS**



PATTERNS AND ALLOYS TO SATISFY MOST INDUSTRIAL NEEDS

For solid reasons, men who ask for the best in Stainless Steel Valves have full confidence when they see the Jenkins Diamond. For almost a century this mark has appeared only on valves made to peak standards of quality in design . . . in castings . . . in machining. JENKINS standards, enforced by the most rigid inspection and testing in the valve industry.

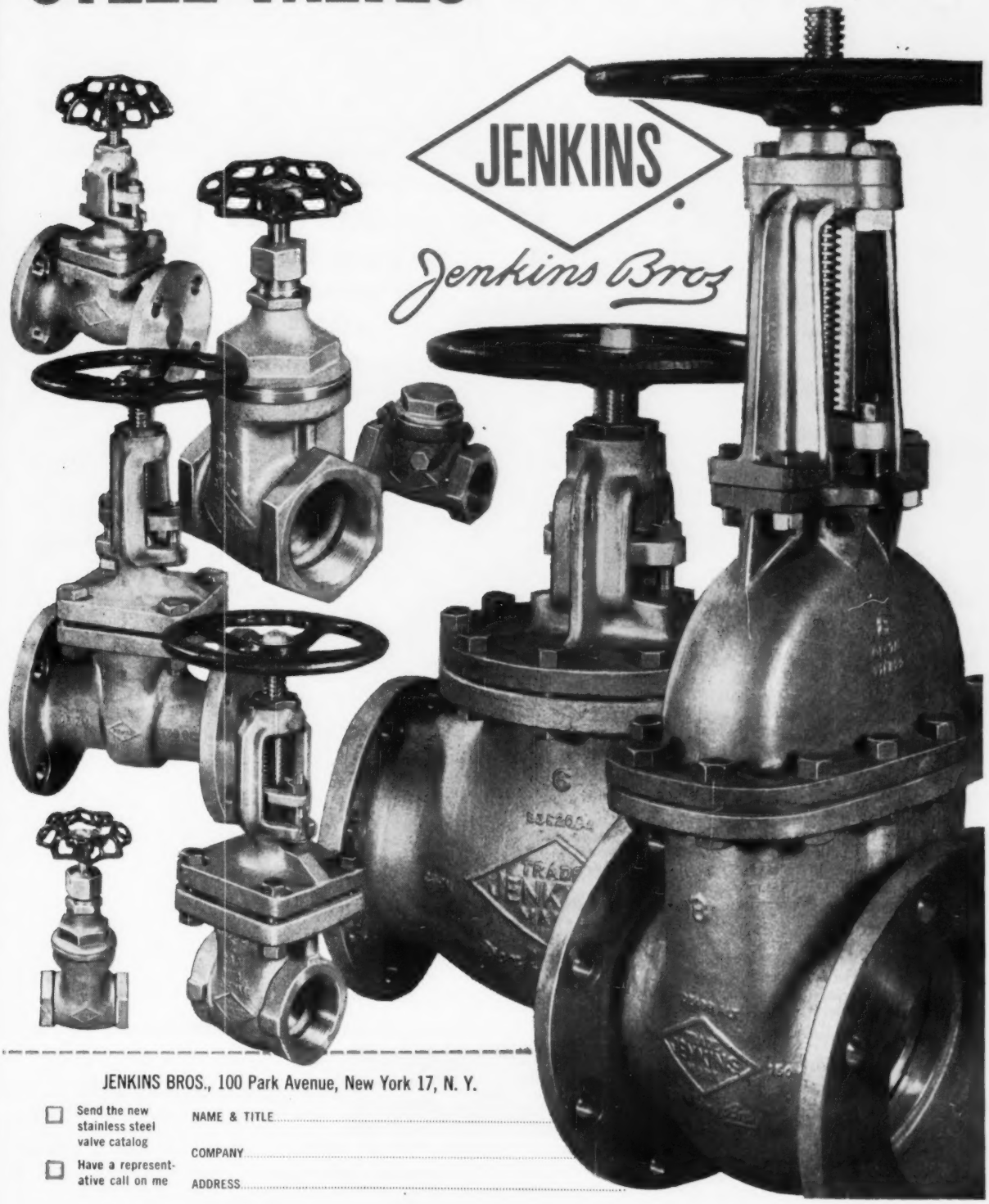
Valves of corrosion resistant stainless steels have been made to those high standards by Jenkins for a quarter of a century. And today, the line of Jenkins Stainless Steel valves includes types and alloys to fully satisfy most service requirements.

They are available through the same leading distributors everywhere who sell Jenkins Valves of Bronze, Iron and Cast Steel.

JENKINS VALVES JENKINS SINCE 1864

this trusted mark

STEEL VALVES *too*



JENKINS BROS., 100 Park Avenue, New York 17, N. Y.

☐ Send the new stainless steel valve catalog

☐ Have a representative call on me

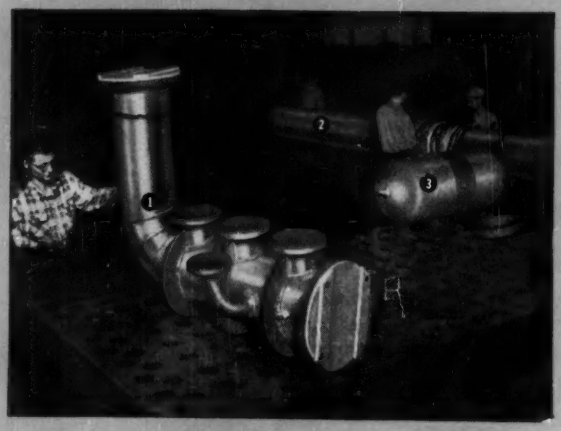
NAME & TITLE .....

COMPANY .....

ADDRESS .....

For more facts circle 239 on Reader Service Card, p 100

ALL IN A DAY'S WORK at *Pittsburgh Piping*



These three jobs are typical of the wide variety of custom piping work which we do for the power and process industries. In the background of the photo welders are shown making the heli-arc root pass on 18" O.D., 3.875" wall, chrome-moly main steam piping. In the foreground, ready for final inspection, is a 12" header for a process operation, fabricated of 3/8" aluminum alloy. The pressure vessel, of austenitic steel, is one of many we produce for atomic energy application. The manufacturing of this type of piping requires specialized facilities . . . for engineering, fabricating, testing, assembly, and erection. We have those facilities. Use them on your piping jobs.

Promoting Progress **IN POWER AND PROCESS PIPING**

Pittsburgh Piping **AND EQUIPMENT COMPANY**
158 49th Street—Pittsburgh, Pa.

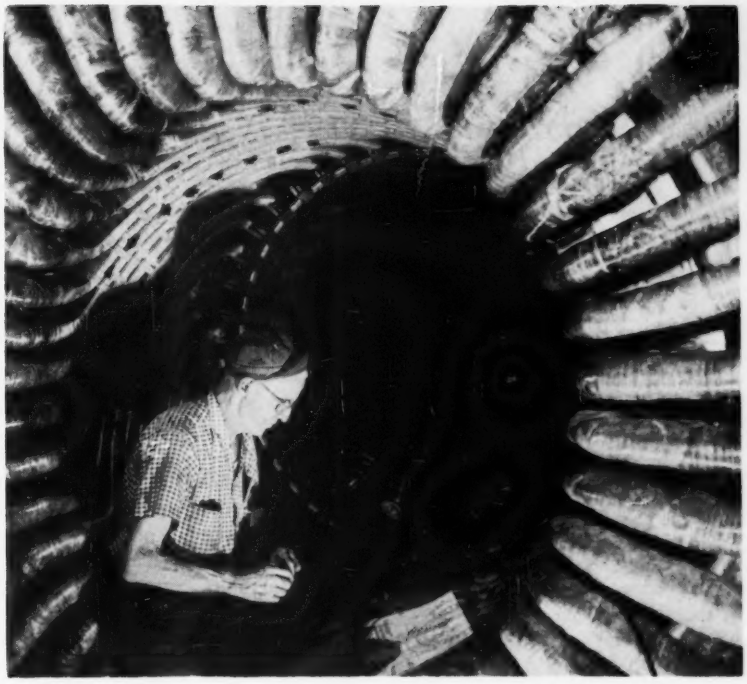
Canada: CANADIAN PITTSBURGH PIPING, LTD., 68 YONGE ST., TORONTO, ONTARIO

Atlanta ..... *Whitehead Building* *Cleveland* ..... *Public Square Building*
Chicago ..... *Peoples Gas Building* *New Orleans* ..... *P. O. Box 74*
New York ..... *Woolworth Building*

For more facts circle 240 on Reader Service Card, p 100

Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge



LIQUID-COOLED STATOR has hose connections to coils integrated into insulation system

Fluids vie for generator cooling

Gas or liquid streams in intimate contact with current-carrying conductors of stator and rotor is today's approach to licking heat-removal problems

By NORMAN PEACH, Assistant Editor

The fast-growing demand for electrical energy has kept turbine-generator designers on their toes searching for new methods to get more capacity out of individual generators without increasing dimensions proportionately. Generators of 350 mw are now in the works, and machines of 500 mw at 3600 rpm are being talked about. These large capacities have been made possible by *conductor cooling*—methods that bring the cooling fluid in close contact with both the stator and rotor conductors rather than requiring major heat transfer through ground insulation.

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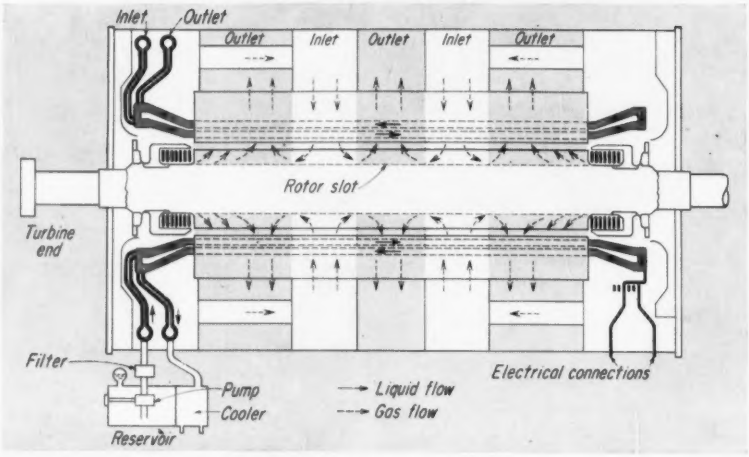
Liquid cooling is some builders' answer to stator-coil heat-removal problem



LIQUID-COOLED STATOR uses flow in closed-circuit to remove heat from coils. Rotor is cooled by gas, picked up in gas gap; it circulates through passages in conductors

Keep in mind that when we speak of generating capacities, we're discussing individual alternators, not cross-compound multiple-generator units. When you hear predictions of 1000-mw generators, what is usually meant is cross-compound units with two 500-mw generators. In the light of history, however, we need not think of 500 mw as the limit of single-generator capacity. Problems other than generator cooling, relating to both turbine and generator design, are likely to be limitations.

Conductor cooling means circulating liquid or gas through the stator conductors either in direct contact with the bare metal or in contact with thin insulation. Gas is circulated in a similar manner through the rotor conductors. As yet nobody is promising a liquid-cooled rotor, but engineers both in the U.S. and Europe are not neglecting this possibility. Conductor cooling of generators with high-velocity hydrogen is employed by both the Allis-Chalmers Manufacturing Company and Westinghouse Electric Corporation in the United States. This method has proved itself by seven years of operating experience. Liquid cooling of stator windings was introduced by the General Electric Company in a plant put in operation in 1956. The coolant was mineral oil. Recently General Electric announced plans to build generators with water-cooled stators.

European engineers are also developing these two methods of stator cooling. Metropolitan-Vickers Electrical Co Ltd, of Manchester, England, was the first to put a water-cooled generator on the line. This was a 30-mw unit intended as a field performance test. It has been running successfully since December 1956.

Relative merits of gas and liquid for inner cooling of stator will be brought out as these methods are described. First, let's take a look at liquid cooling.

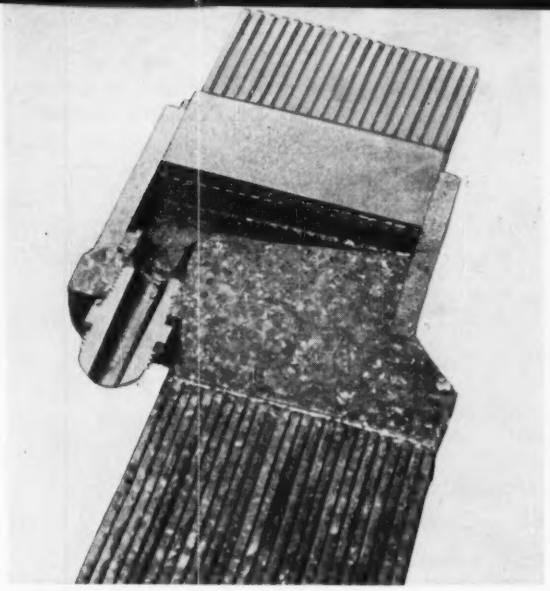
Liquid circulated through hollow conductors in direct contact with the bare metal is a very effective method of removing heat. The relative heat-removal ability of water is approximately 50 times that of air, and 12.5 times that of hydrogen at 45 psig. Advocates of water claim it's so effective as to remove insulation temperature as a limitation on coil's current capacity. They say maximum current per conductor is now limited by I^2R loss.

The way in which liquid is circulated through the windings of present-day GE stators is illustrated both above and at right. The coolant (oil or water) is fed from inlet manifold through an insulating tube into a special strand header that leads the liquid into one of the coil sides. The liquid then flows through the coil, out the opposite end of the coil, and back through the other coil side and an insulating hose to the outlet header. From the outlet header the liquid goes to a heat exchanger, then to a filter or purifier before it is returned to the generator's windings. Flow is in a closed system.

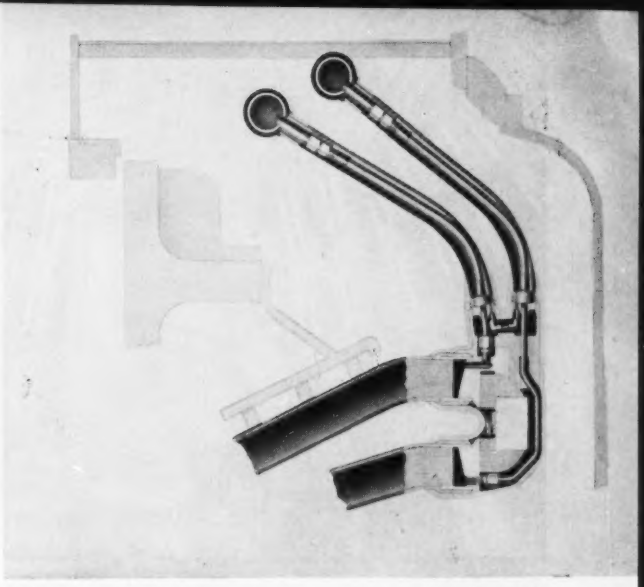
Hollow strands of copper make the most effective liquid-cooled coils. The coolant is brought into direct contact with the conducting metal, which is the most efficient use of cooling area, and makes possible the most compact and efficient winding design. Strands in the form of rectangular ducts are transposed like ordinary solid strands by a Roebel transposition. Extensive tests have proved that this forming of the strands does not cause significant reduction of the liquid passage.

For certain sizes and voltages of generators it has been considered that it may be advantageous to use cooling ducts included inside the bar instead of hollow conductors. The strands in such a case would be transposed before they are bound to the ducts. Although heat removal isn't as effective, there might be advantages with respect to strand dimensions, permissible eddy-current losses or coil proportions.

Hydraulic connections are made on the end of the stator opposite the electrical connections. Hollow strands



STRAND HEADER for series connections feeds coolant from the hose into hollow copper strands. Brazing makes tight joint

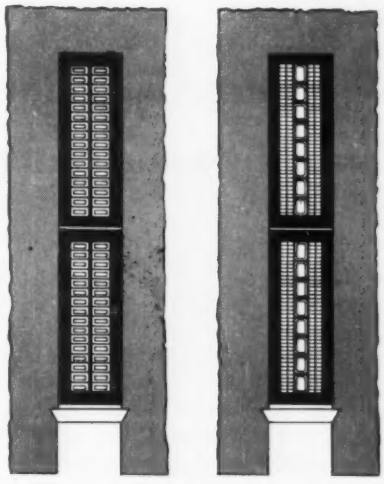


HOSE CONNECTIONS carry liquid between strand headers on the coil's "nose" and liquid manifolds. Teflon hoses serve as insulators

are brazed to the hydraulic clip, and a metal fitting for tube connection is also brazed in place. Solid strands are used in the bend between the strand header just described and a similar header on the end of the coil side to which it is joined. The liquid circuit is therefore split, flowing in through one hose and out the other after cooling the coil. The completely assembled joint is then insulated in the manner normally used to insulate series connections.

Liquid connections on present designs are of the simplified type shown at upper right. Teflon tubes are used to carry the liquid. These provide the electrical insulation needed and at the same time do not develop leaks under vibration and mechanical stress. An outer tube serves as extra protection if a leak occurs. Gas in space between tubes is kept at the same pressure as rotor-cooling gas which fills casing. More elaborate tube arrangements were used in the first liquid designs, including leak detectors.

Construction of the British water-cooled generator is similar to the machine described, except that inlet is at one end of the stator and outlet at the other. Liquid flows through all the coil sides in parallel between the inlet and outlet liquid manifolds.



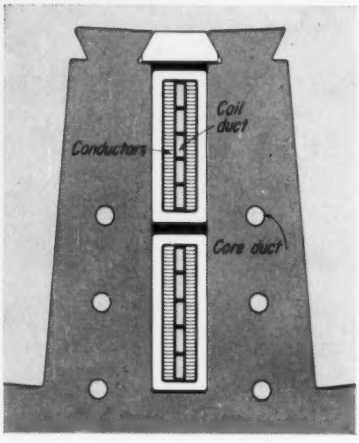
HOLLOW STRANDS or included ducts convey coolant through bars of each coil

Advantages of water for heat removal make it attractive, but its use brings up some questions, such as (1) Is electrical resistivity of high-purity water sufficient with adequate margin against flashovers through or along the hoses? (2) Is it practical to maintain high-purity water? (3) Will there be significant erosion or corrosion of conductors and cooling circuits? (4) Is the possibility of a leak likely to be more serious with water than with oil or hydrogen?

Extensive tests by General Electric convinced this manufacturer that water can be used safely and without complicated equipment. Other liquids were tested for dielectric strength, chemical inertness, availability and cost. GE believes that water is superior in these properties and, in addition, is nonflammable.

Their laboratory tests, in the opinion of General Electric engineers, indicate that a resistivity in the range from 100,000 ohms-cm to 500,000 ohms-cm is value desirable for normal operation. An 18-kv generator with cooling water of 200,000 ohms-cm has a total leakage-current loss through the insulating connections of about 400 watts. Flashover tests show that resistivities above 100,000 ohms-cm provide ample margin at typical generator voltages. Corrosion tests indicate a rate for copper of 0.02 mils per year. Erosion tests of 1500 hours at various water conditions show no significant effects

GAS-COOLED STATOR has duct openings at coil ends. Hydrogen is forced through both coil sides in same direction, exhausts from opposite end of stator, removing coil heat



STATOR SLOT and core cross-section shows coil ducts and core gas passages

High-pressure high-velocity gas is conductor-cooling method preferred by some stator and rotor designers

on copper conductors even at velocity of 20 ft per sec.

Purity of the few hundred gallons of water needed can be maintained, according to GE, by a relatively small mixed-bed demineralizer, with a filter ahead of the demineralizer for initial cleanup period. Resistivity is monitored on the downstream side of both the cooler and purifier.

Automatic regulation of coolant flow that makes it possible to reduce the range between maximum and minimum temperature of coils as loading varies, thus reducing thermal expansion, is an advantage claimed for liquid cooling.

Now, a look at gas-cooled stators. Conductor cooling by gas is accomplished by circulating hydrogen at high velocities through ducts in the coils and, in some designs, through the core also. Pressure and velocity is obtained by compressors, usually single-stage centrifugal or multi-stage axial type mounted inside the generator yoke.

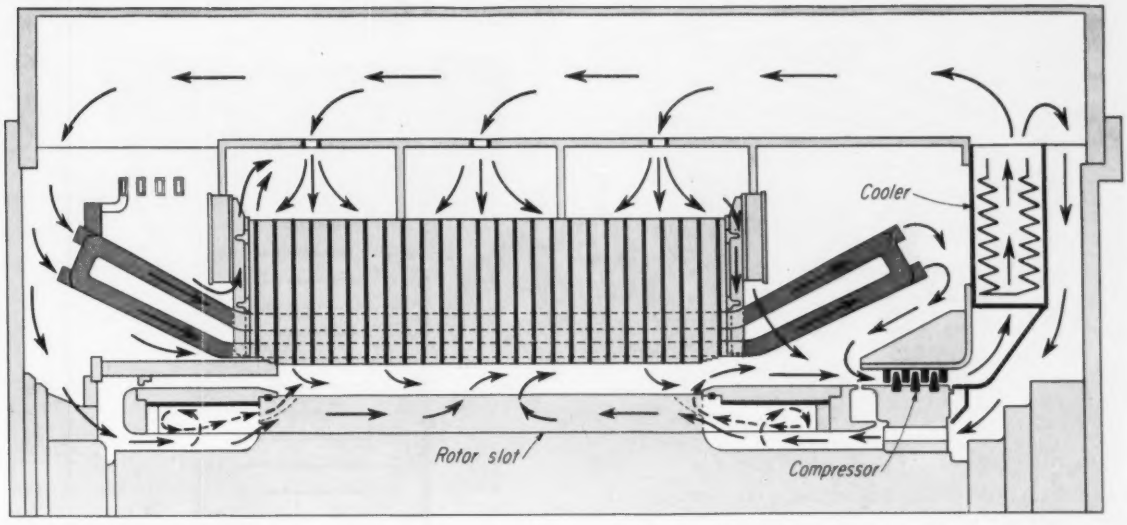
One gas-cooled design is shown top, right. Gas from the compressor passes through the cooler and is then distributed by several routes. Part goes through radial stator ducts, and part through the rotor's ventilating system. Stator-coil ducts are stainless-steel with relatively thin insulation. They're bound with the transposed strands to form the coil sides. The cooling hydrogen is thus brought into close contact with the conductors. Ducts of each coil side are open at both ends. Gas enters at one end of the stator coils and leaves at the other end. Insulated orifices may be placed at the ends of the metal ducts and incorporated into the coil insulation. The illustration is based on a Westinghouse Electric Corporation design.

Typical Allis-Chalmers Manufacturing Company design makes use of a stator core ventilated end-to-end by gas flowing through axial ducts formed by punched holes in the stator core laminations. This feature, it is claimed, economizes stator-core space and minimizes temperature difference between copper and iron. In this design the leads are hollow copper tubes ventilated in parallel with stator core and coils. Terminal bushings are also gas conductor cooled. Illustrations, above, are based on Allis-Chalmers designs.

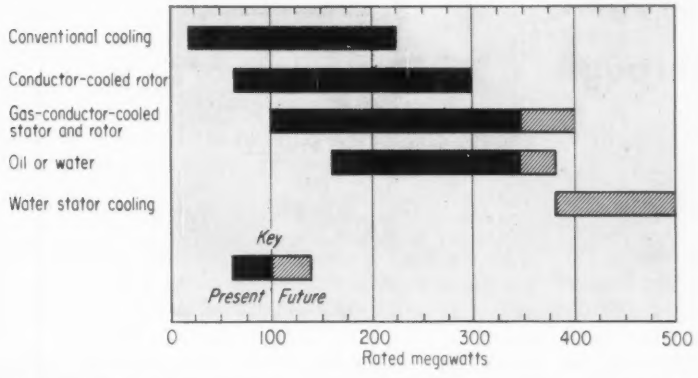
Current-carrying capacities of typical gas-conductor-cooled coils are illustrated by curves, far right. Gains over conventional (through-insulation) cooling rise sharply as pressures go up.

Comparison of gas and liquids for conductor cooling raises many points on which generator design engineers will not agree. Proponents of gas conductor cooling point out that in either case rotors are gas cooled, p 60, and so are stator cores. They maintain that rotor cooling is a more serious problem than stator cooling. On the other hand, liquid cooling is very effective. Development of liquid-cooled rotors would permit nonflammable, nonexplosive coolants. (The casing could be filled with a low-pressure inert gas.)

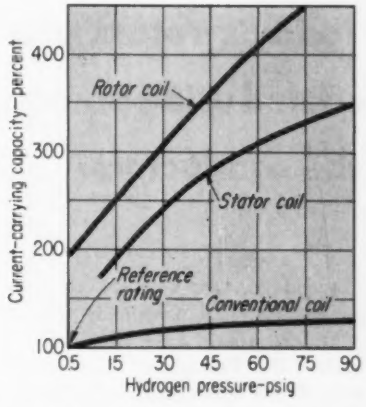
Relative complexities of the two systems depends on your point of view, too. Against the numerous hose connections and danger of leaks with liquid cooling, can



GAS CONDUCTOR-COOLING is used for both stator and rotor. Compressor, *right*, drives hydrogen through cooler. After cooling, gas is distributed by different paths through stator-coil slots, stator core, hollow rotor conductors and around rotor, stator end windings



COMPARISON of ratings of single generators using different cooling methods. Curves are composite of U. S. practice, represent today's unit, expected capacity expansion



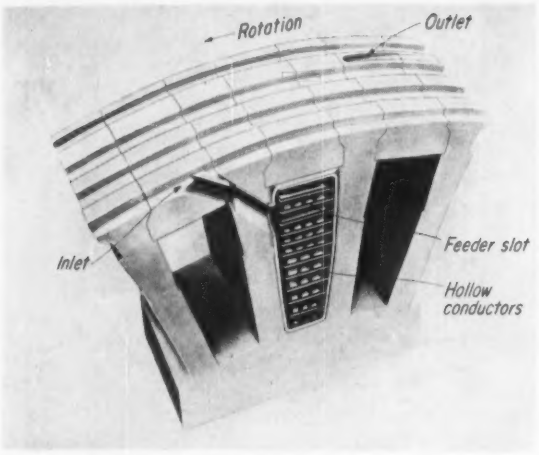
INCREASED CAPACITY of generators is pronounced using gas conductor-cooling

be offered the additional mechanical complications in assembly and disassembly resulting from the addition of the hydrogen compressor inside the generator yoke.

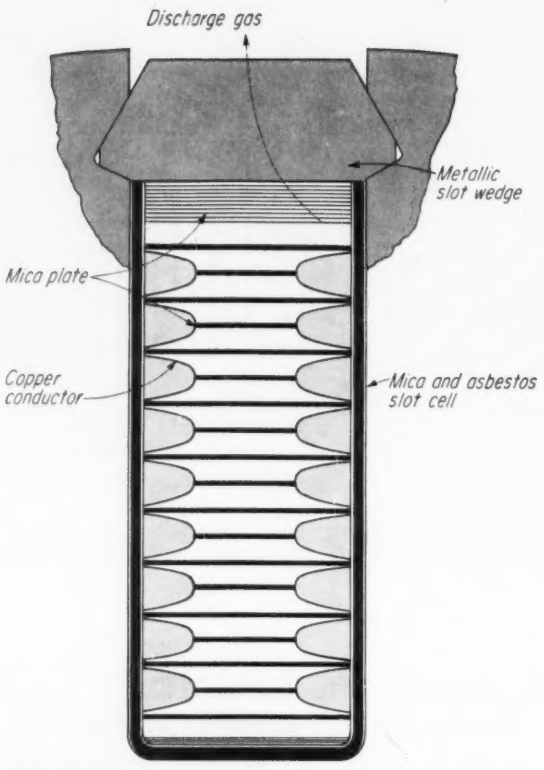
Capacities of generators using the various methods of cooling now available are shown in chart, above. This is a composite of generator manufacturers' views in the United States. It's pretty much in line with the thinking in Europe, too. Two-pole machines in Europe run at 3000 rpm (50 cycles), with result that rotor stresses are not as severe as they are at 3600 rpm. On the other hand, there seems to be less inclination to adopt cross-compound generators, and transportation difficulties sometimes impose limitations on generator dimensions.

High outputs of inner-cooled machines involve engineering considerations apart from those immediately concerned with cooling. Doubling rating by means of rotor and stator inner cooling results in about doubling the excitation loss per unit of rating. In general the copper losses are up and the iron, friction and windage losses are down. Net efficiencies (including reduced losses of smaller bearings) are about the same for present inner-cooled designs as for conventional types. Reactances are much higher, but in 2-pole machines high subtransient reactance is desirable to limit faults.

Rotor conductor cooling preceded application to stator windings. There are two general types today:



GAP-PICKUP PRINCIPLE is demonstrated in this rotor section. Rotation forces gas through inlet into copper channels, then out



END-FED CONDUCTOR COOLING SYSTEM either employs conductor passages of the type shown or uses hollow copper conductors

Today's rotors are hydrogen cooled using passages through the conductors

(1) end-fed, used with gas-conductor-cooled stators (2) gap-pickup, used principally with liquid-cooled stators.

End-fed rotors have lengthwise passages through the rotor coils. Passages in some designs are at sides of the slot, shown upper right. They're formed by chamfered edges of conductors. High-velocity hydrogen contacts two conductors while going through each passage. The same conductor shapes have been used with a tapered slot. Another design uses hollow conductors formed by pairs of channel-shaped pieces of copper. A variety of channel sizes are required for a tapered slot.

Typical end-fed rotor, top of p 59, has portions of cooled high-velocity gas fed into rotor from both ends. Gas goes through passage along shaft under end windings. Part of this is used to cool the end windings, then is discharged. Rest of cool gas is fed into axial conductor passages through radial holes. This takes place under the retaining rings outside of the core proper. The hydrogen then flows axially through the conductor passages to the center of the rotor where it is expelled through another set of radial holes into the air gap. Heated gas then flows out through air gap. Centrifugal forces of rotor help produce flow of the coolant.

Gap-pickup technique depends on a large number of relatively short-length parallel cooling paths for flow of gas through conductor channels, top, left. Scoop-like inlet hole through metal slot wedge and tooth brings gas to passages in conductor channels. Crosswise openings in the channel ribs feed gas into lengthwise passages. After traveling for about two feet along the conductor the gas is expelled through the outlet hole into the air gap. Gas is fed into sections of the air gap opposite the rotor inlet holes through ducts in the stator core. Heated gas is exhausted from sections of the air gap opposite the outlet holes, likewise through ducts in the stator. The air gap is thus alternately inlet and outlet along its length, top, p 56.

Simple low-pressure fans circulate the cooling gas external to the rotor. Rotor itself, by its rotation, forces the gas through the conductor passages. Conductors are made from two interlocking channels. Pairs of channels are insulated from each other by sheet insulation composed of inorganic fibers and hard synthetic impregnants to avoid possibility of flaking. This turn insulation is used on the smooth side of the hollow copper channels.

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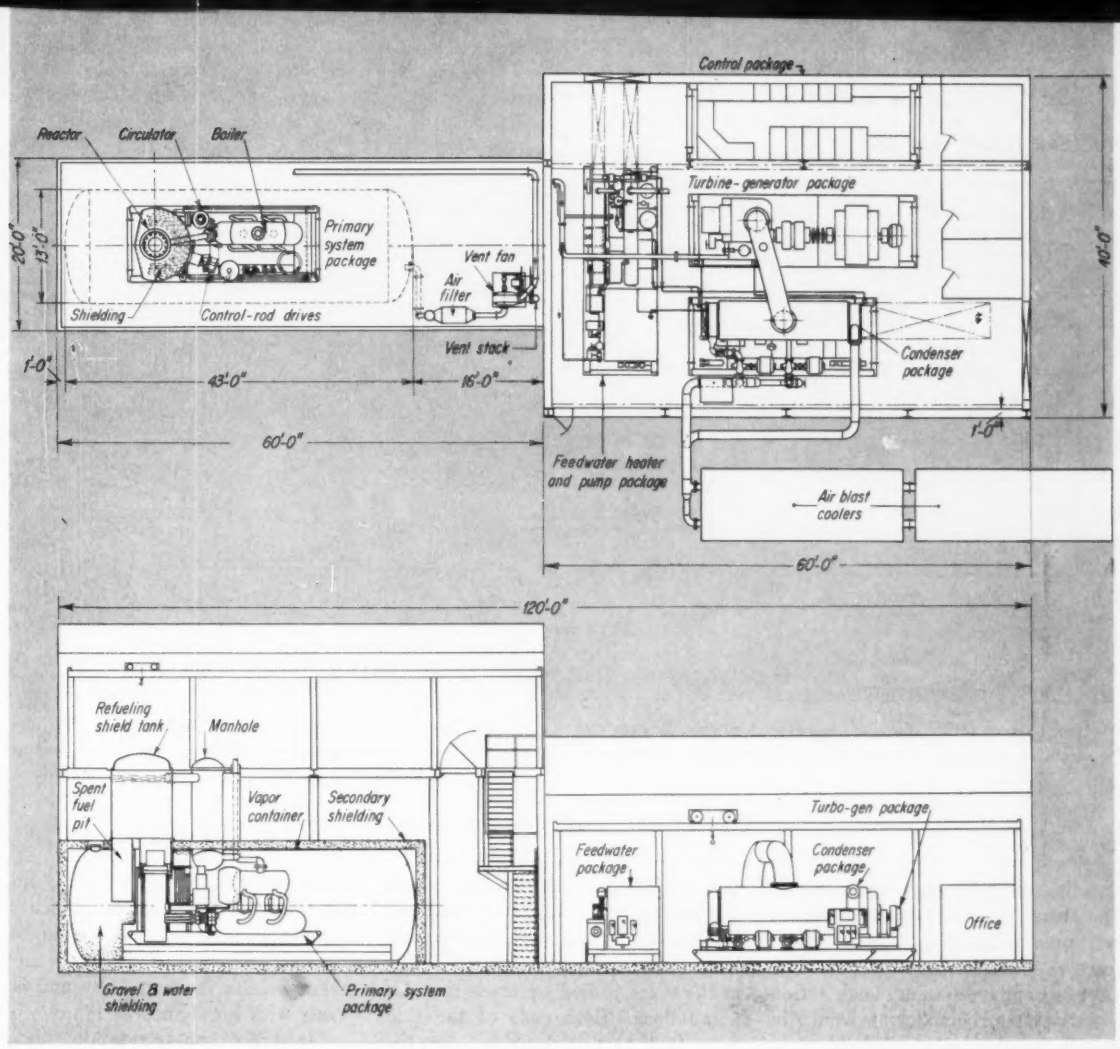


1 Primary-loop equipment of pressurized-water reactor mounts on two skids, *left*. Vapor container and secondary shielding house primary loop to protect operators. Steam flows from boiler to turbine behind condenser, *right*; note feedwater package, *center*

Portable nuclear power plant offers...

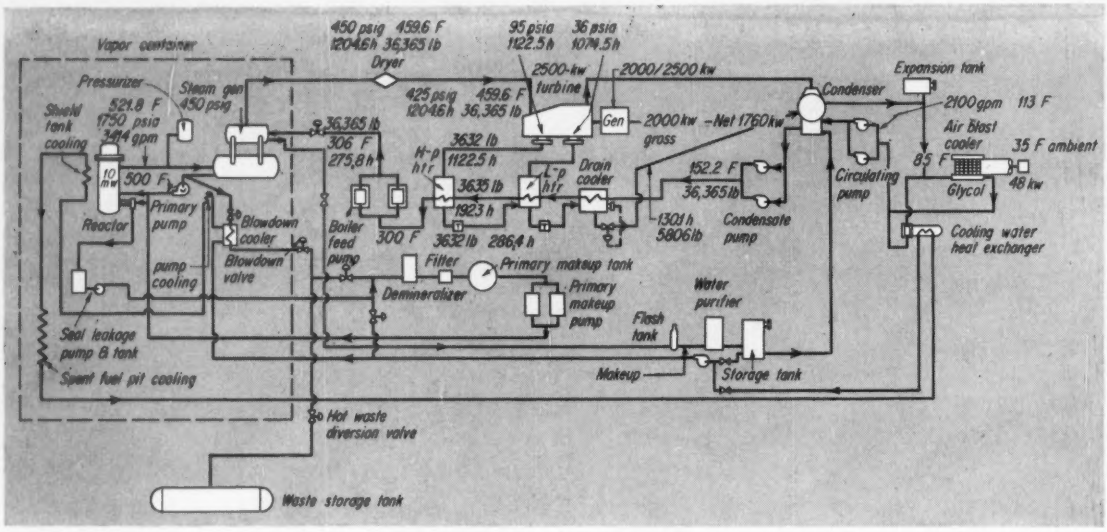
. . . operating flexibility, easy maintenance and long fuel life for remote industrial, mining and military sites

Successful operation of the Army Package Power Reactor (APPR-1) at Fort Belvoir, Va., laid the foundation on which to design a portable power plant. Alco Products, Inc has extended their experience with the APPR-1 to the design of a nuclear power plant that can be run at a site, then dismantled and moved to operate at another distant site.

The plant elements can be carried in large cargo planes. This limits packages to 30,000 lb with dimensions of no more than 30x9x9 ft. Components mount on skids to form these packages and quick-disconnect electrical connections and flanged pipe joints tie them together. Grouping of components makes assembly and operation easy, allows maximum accessibility for maintenance, Fig. 1.

Studies showed that the size, arrangement and cost of this type reactor varied little between gross outputs of 2.5 to 10 mwt. One basic reactor can supply electrical power, or space heating or both for plants in this power range.

Lower output plants would get increased core life and have reactor



2 Heat balance for 2.0-mw plant uses two feedwater heaters and drain cooler in steam-water circuit. The 10-mwt reactor supplies heat through one primary loop pressurized to 1750 psia. Air blast cooler dissipates heat picked up by the main condenser

capacity to meet growing demands. The steam generator, primary pump and pressurizer are flanged to the reactor piping and can be sized to meet secondary-system loads. Secondary-system components would be chosen for the particular load to be carried, Fig. 2.

Reactor core uses the APPR-1 fuel elements in a 7x7 array with three elements per corner removed. This makes up in an equivalent cylinder 20.16 in. in diameter and 22 in. high. Actual APPR-1 elements have been running for over 18 months with good results.

Removing the eight corner elements from the APPR-1 core for this design and eliminating the thermal shield markedly shrinks pressure vessel diameter, Fig. 1 and 3. This gives remarkable size and weight savings.

Reduced size lowers the initial cold reactivity from 15.4% for the APPR-1 to about 9.7%. Estimated lifetime based on equilibrium xenon override is about 8 mwyr, table, page 63.

UO_2 loading can be increased to lengthen lifetime, if needed. Present loading of 23% (by weight) oxide in the matrix is well below the metallurgical limit of about 35%. Raising the oxide loading from 23 to 25% is expected to raise the core life from 8 to 11 mwyr. These expectations must be checked out by actual test.

Packaging. All primary and secondary packages mount on skid bases; the skids have two H-beams at the sides joined by cross ties and a top deck. Both ends of the skid have draw bars mounted between the H-beams. The skids hold all electrical and instrument wiring in conduit secured by ferrules in the cross ties. Outlet boxes and electrical connectors are above deck.

Components use top decks as mounting pads. Mountings care for thermal expansion where needed. The skid base forms a rigid structure that needs only a small foundation.

Where packages are air transported, the primary package and turbine-generator package would be mounted on two skids each. The 2-skid assemblies are doweled and bolted together in the shop and the complete package checked out. Skid bolting and component flanges disconnect at the parting line. Draw bar ends bolted to the skid parting faces protect the matching faces and make a skid for shipping. Blind flanges cover the disconnects.

Assembly. All components of primary and secondary systems mount on the skids and have a minimum of connections to be made at assembly. Metal gaskets with asbestos or Teflon fillers seal flanged pipe joints; this gasket has given excellent service at control-rod-drive penetrations in the APPR-1. Prewiring in the shop makes field connections easy and accurate with no chance of faulty wiring or reverse motor rotation.

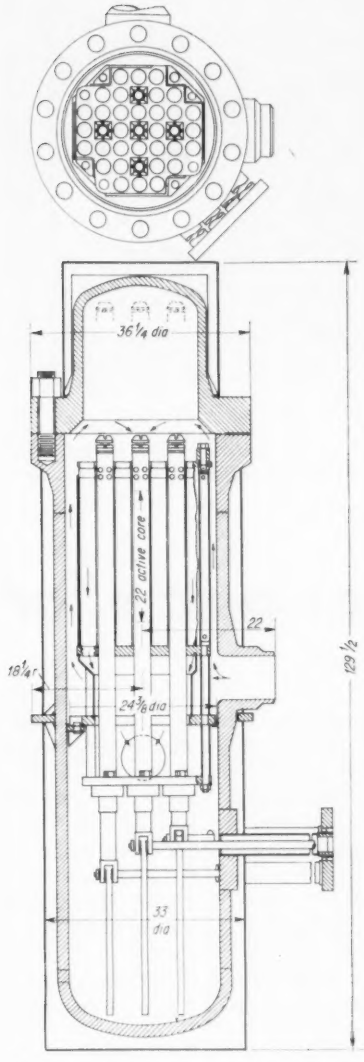
Ample space on the skids allows replacing parts such as control-rod drive shafts, pressurizer heaters, pump impellers, packings, etc. Skids are arranged in the plant to allow replacing tube bundles in the feedwater heaters and condenser and to pull the generator rotor. Flanged primary nozzles give access to the steam generator tubes. The complete plant can be checked out in the shop before shipment.

Primary system. The fully assembled primary skid, Fig. 1, weighs 84,650 lb and includes: (1) reactor vessel (2) primary pump and piping (3) steam generator (4) pressurizer (5) blowdown cooler (6) seal leakage pump and tank (7) primary shielding. Reactor skid weighs 29,325 lb and steam generator skid 25,500 lb. Removable shield rings, shipped separately, weigh 29,825 lb. Skids are bolted and doweled together in the shop and may be separated into two packages to meet air-shipment limitations.

Reactor vessel, Fig. 3, has the

Proposed portable nuclear power plants

Plant	A	B
Thermal power developed in reactor, kw	6500	10,000
Electrical power generated, kw	1000	2000
Net electric power delivered, kw	820	1760
Power required for auxiliaries, kw	180	240
Steam for heating, Btu per hr	5×10^6	0
Core life between refuelings, mwyr	8	8
Core life based on 80% plant factor, yr	1.5	1
Full-load data		
Operating pressure in reactor, psia	1750	1750
Coolant inlet temperature to reactor, F	500	500
Coolant outlet temperature at reactor, F	523.5	521.8
Coolant flow through core, gpm	2050	3420
Number of flow passes through reactor	1	1
Heat transfer area, sq ft	496	496
Unit heat transfer, Btu per hr, sq ft	44,730	68,810
Maximum fuel-plate-surface temperature, F	610	611
Boiling temperatures at 1750 psia, F	617	617



3 Pressurized water reactor has 32 fixed fuel elements and five control elements. Active core height is 22 in. and core diameter is about 20 in. Coolant enters side nozzle, flows up through annular space and down through the core elements to leave through the lower nozzle at the rear

coolant nozzles below the active core of the reactor. The core structure with its mounting flange acts as the flow divider between the inlet and outlet chambers of the vessel. Coolant enters through the upper nozzle and flows to the top between core structure and vessel wall, then down through the core and out through the lower nozzle. The downward flow through the core gives an additional force for scramming the control rods.

Core structure has an upper and lower grid for positioning the fuel elements, flow divider sheets, dash pot cylinders and pinion bearing supports for the control-rod drives. The upper grid mounts and orients on four tie rods.

During core refueling the upper grid is removed and stored in the shield tank. Upper grid has guides for aligning control rods. Orifices in upper grid distribute coolant through the core while the lower grid holds the fixed fuel elements in the proper pattern.

Shielding. Major part of the primary shield must be shipped as an integral part on the primary skid since it accommodates various reactor vessel penetrations. Primary shield is designed for shutdown shielding only as in APPR-1; however, it prevents activation of primary components during operation.

Shield has four 3-in. thick steel rings sandwiched between ⅛-in. thick boral sheets. Water fills the 2½-in. gaps between the sandwiches and the 8-in. annulus between reactor vessel support ring and the first sandwich.

Shield rings do not surround the reactor vessel since the primary system need be approached only from the front section, Fig. 1. Rear section of the vessel can be shielded by filling the rear portion of the vapor container with a mixture of gravel and water. This shield would be augmented by two 1-ft thick concrete walls about 2 ft apart with the intervening space filled with gravel or dirt found at the plant site.

Fuel handling. A bulkhead separates the primary compartment in the vapor container from the spent fuel pit. Access passageway to the primary compartment stands over the primary-coolant pump, giving adequate space for pump removal. An adjacent chamber holds the piping and electrical penetrations into the vapor container.

Fuel elements will be handled manually with long-handled tools. Spent fuel elements can be lifted from the core and dropped into the adjacent spent-fuel pit when the refueling shield tank is filled with water. Shield tank has space to hold the radioactive parts of the upper grid and control-rod caps during refueling operations. The spent-fuel cask can be lowered into the spent-fuel pit to remove elements after the decay period.

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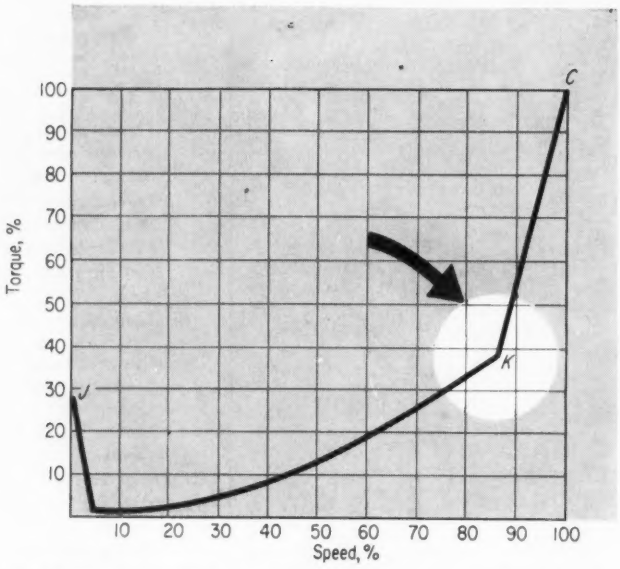


1 Operating load curve, *above*, aids in motor selection. If you can determine point *K* with accuracy, motor maker can figure rest of curve

Are you sure of the really critical points when applying motors to boiler-feed pumps? They all center around starting and operating load needs, with emphasis on the point where check valve opens

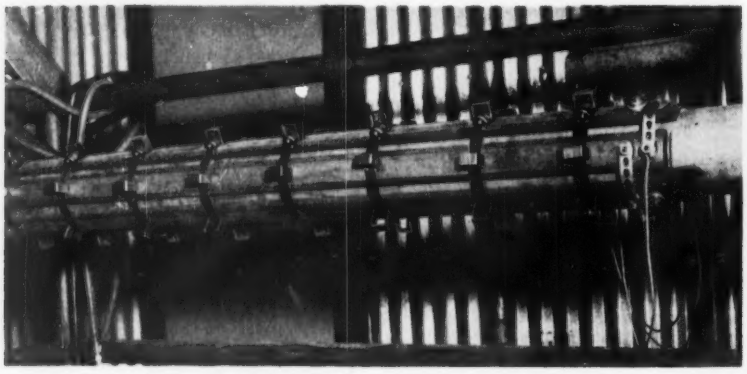
Torque-speed is your motor guide for

Study the curve in Fig. 1. If you can pin down pump speed and torque at point *K*, *point where the check valve opens*, the motor maker can usually estimate rest of the curve with sufficient accuracy. Naturally, correct pump-load curve must be used. All too frequently the test-load curve, box, facing page, is confused with the operating-load curve. Keep in mind that actual operating conditions vary from the test conditions.

Check valve in pump's discharge line plays a key role in the motor application. Until the check valve opens, load torque that the pump imposes on the motor is akin to that of a pump starting with its discharge valve closed. When check valve opens, torque required by pump increases rapidly to full-load torque at full speed. In unusual cases check valve may open at 70% speed or as high as 94%. More often the point falls somewhere between 85 and 92% speed.

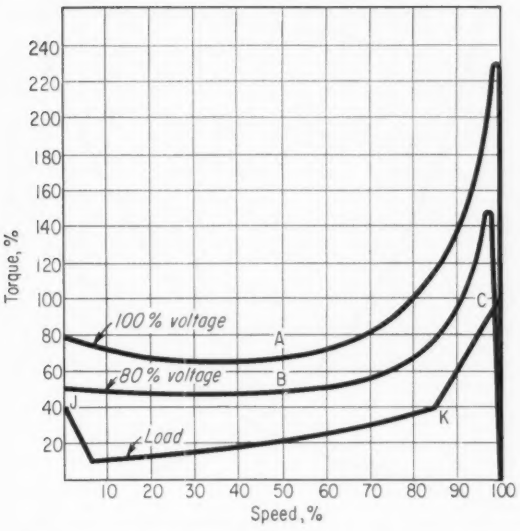
Voltage tie to motor speed-torque curve is shown in Fig. 2. Curve *A* is full-voltage plot of speed-torque for a typical 2000-hp 3600-rpm 4000-v motor. This curve would be essentially the same for motors in the 3000 to 5000-hp range. Curve *B* is speed-torque plot for the same motor operating at 80% voltage.

Curve *J-K-C*, Fig. 2, is the same pump curve as in Fig. 1. If the check

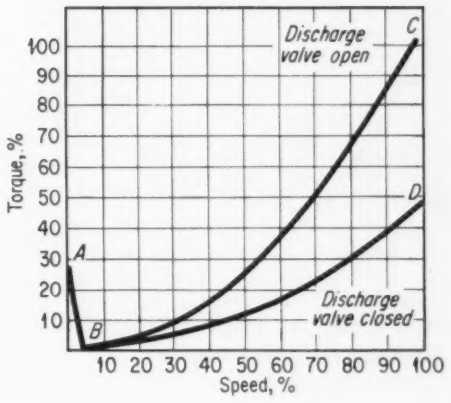


PREFORMED pipe covering surrounds aluminum **ELECTRIC STRIP HEATERS** are fastened to pipe with stainless-steel hose clamps

Pipe heating with



2 Typical curves for a 3600-rpm motor. Load and motor curves should be separated by the equivalent of 10% full-load torque



Check valve plays lead role

In everyday practice, where the pump is started against operating boiler pressure, the discharge valve is normally open. But there is a check valve in the line between pump and boiler that prevents boiler pressure from forcing water back through pump before the latter gets up to speed.

Once the pump speed reaches a point where developed pressure is equal to boiler pressure, the check valve opens and pump feeds boiler.

boiler-feed pumps

valve opens at 87% speed, point *K*, motor at 80% of full voltage will have enough torque to accelerate the pump to full speed.

Although inertia of a boiler-feed pump is quite low, unit will accelerate successfully if motor speed-torque curve is above pump speed-torque curve by at least 10% of full-load torque *at point of least spread between curves.* In Fig. 2, if check valve (curve *B*) opened at 80% speed, there would be a narrow margin between motor and load curves at the 90% point. This comes about since point *K* would be shifted back along the load curve to the 80% spot. Now new line *KC* is developed. Because of this narrow torque margin, motor would accelerate slowly resulting in motor heating.

Again referring to Fig. 2: If check valve opens at 70% speed, pump and motor curves would intersect at about the 85% speed point. As a result, the motor would not accelerate beyond this value of speed.

Motor design, to meet voltage values and speed-torque requirements of pump at point where check valve opens, may lean toward a unit having high starting currents. But to keep starting currents as low as practical and still get enough torque, may require increasing rotor resistance and thus reducing full-load speed.

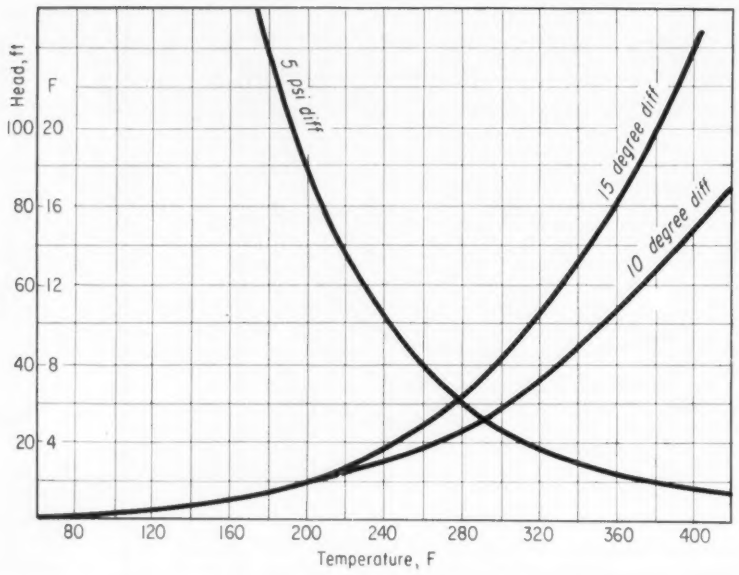
electric elements calls for some common-sense precautions

The question was posed: "What's the best way to heat a large circulating loop made from 3-in. Schedule-160 stainless-steel pipe?" The piping was part of the test setup being built at GE's atomic power facility in San Jose, California. All concerned knew heating piping with electrical elements required: (1) getting a tight fit between pipe and elements (2) fastening or welding to pipe be held to a minimum (3) adequate separation between heating element and insulation to prevent hot spots (4) creation of an oven effect.

H J Pfeifer, construction engineer, and J T Cochran, design engineer, devised scheme shown by photos, left. Stainless-steel clamps strap heaters to pipe. Then ¾-in. square spacers are clamped on top of each heater, about 5-in. apart, to support 28-gage aluminum wrapper. Latter serves to keep insulation from flaking off while acting as a heat reflecting oven.

Preformed pipe covering covers aluminum wrapper, photo. Electrical connections are carried through ceramic beads and tubing to a splice box. Piping exposed to weather is protected by a waterproofing emulsion. High-temperature glass tape is also used on the connections.

By R H FREDERICK, (ret'd)
Domestic Pump and Mfg Co



1 Effect of maintaining either a constant temperature or pressure difference between saturated conditions and actual conditions desired at pump inlet is shown by curves

Not enough head at a pump inlet causes vapor-locking and often offsets efforts of the pump designer. So, most makers say . . .

Use a service factor at pump inlet

One of the more troublesome problems in pump application is found at the pump inlet side and comes from not enough inlet pressure. The trouble crops up most frequently when handling hot liquids, especially if they're at or near the saturation point before getting to the pump.

Hot water near the boiling point can drop to or below the saturation pressure because of piping, entrance and velocity losses met before reaching the pump inlet. To overcome this, a head of water is provided between the supply tank and pump. But this head is often figured too close, causing trouble. As a counteraction, pump manufacturers recommend using inlet pressure with a built-in service factor.

The problem is determining the difference between what the pump should do (including losses) and what it actually will do. Here the service factor takes over, giving a cushion to cover the unknown.

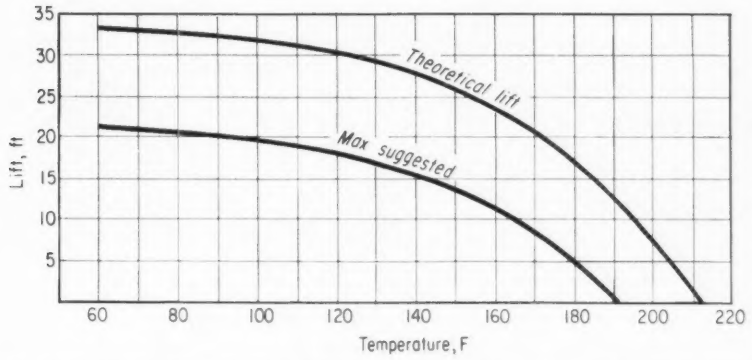
Experience has given the pump manufacturers a good idea of what reliable inlet pressures should be. These aren't set values, but vary according to the operating temperature and pressure of the water.

Curves on these two pages help to show you where a service factor is most needed. The two curves sloping up to the right, Fig. 1, show the head in feet of water needed to keep a constant temperature difference between saturation and actual inlet conditions. The 15-F curve is recommended for water at 212 F or below. The 10-F curve starts with a 15-F spread at 212-F water and gradually decreases to a 10-F difference by the time water temperature gets to 400 F.

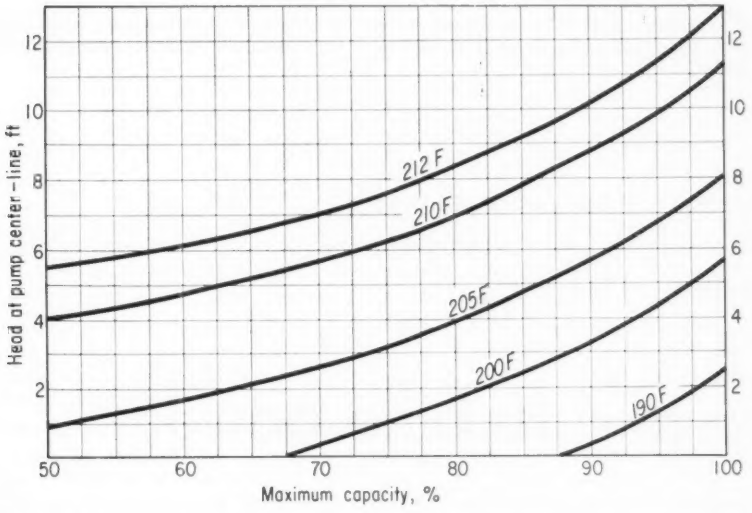
Maintaining a constant pressure difference between inlet and saturation conditions produces a drop in temperature difference between the two as the actual water temperature increases. Curve 5 psi is based on a constant 5-psi pressure spread.

Curves in Fig. 2 give both theoretical and recommended maximum lift at atmospheric pressure (sea level). In Fig. 3, the curves indicate the drop in pump capacity when there isn't enough head at the pump inlet. Both sets of curves are based on a 12-foot head of water pressure at the inlet for saturated water at 212 F.

Ambient temperature water at atmospheric pressure can be drawn from a tank over the pump with little to worry about (unless your piping setup creates air locks). But when



2 Lifting power (theoretical) of pump drops as water at atmospheric pressure nears 212 F, as indicated. Lower curve is top suggested lift at same pumping condition



3 Slight increase in temperature over the 180-F mark seriously affects pump capacity if available inlet heads aren't big enough. Curves are based on 12-ft head at 212 F

the water is heated, your picture changes quickly. For saturated water at 212 F most manufacturers say a 5-psi pressure head at the inlet is enough. Although this is a 12-foot water head, you actually need about 15 feet vertical drop from tank to pump to overcome losses.

Pumps can handle water at 212 F saturated with less than this 5-psi inlet pressure, but chances of vapor lock and cavitation occurring make this risky business unless extreme care is taken in system analysis, pump selection and positioning. Two points to consider when figuring if a service factor is worthwhile are the importance of pump operation reliability and the expense of replacing pump impellors ruined by cavitation.

The 12-ft, or 5-psi rule isn't valid when handling water under high pressure and temperatures. For example, if you're drawing saturated water from a tank at 250 psi (401.1 F), and you add 5 psi, the temperature of the water delivered to the pump remains at 401.1 F but the saturation point rises to 402.7 F. Water at the inlet now is not at the boiling point, but the 1.6 F difference is too close for dependable operation.

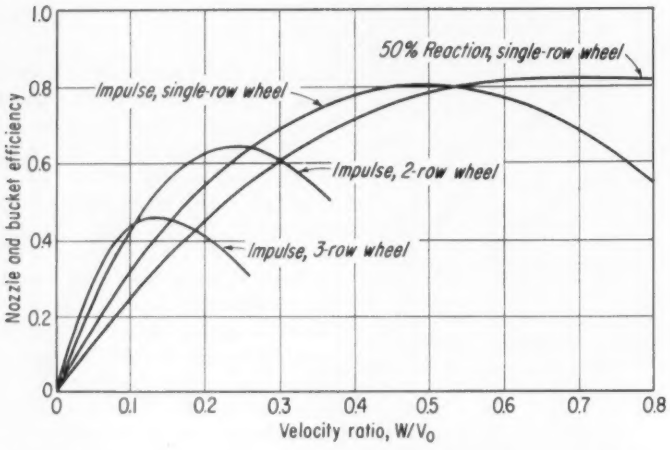
Elevated temperatures and pressures with water are best handled by using a temperature difference instead of a pressure spread between saturated and inlet conditions. Going back to the saturated 212-F example, a 5-psi pressure boost kicks the boiling point up to 227 F (at 19.7 psia). That's a 15-F spread between boiling at the tank and at the pump. To get that much difference when the water is at the 400-F level, you need a 121-ft head. Pump makers have found a 10 F difference is enough at 400 F. Thus by upping the saturation pressure from 250 to 280 psi, you increase saturation temperature from 401.1 to 411 F. This takes a 75-ft water head, but can be achieved by drawing from the tank into a low-speed single-stage pump and then feeding the low-pressure discharge into a high-speed multistage unit.

Service factors at these elevated conditions are necessary. Any sudden drop in system pressure will lower the inlet pressure below the vapor point if your service factor is too small. Also, at light load the pump runs hot, adding heat to the water passing through the casing. This isn't much, but each addition of heat or dropping of pressure brings the inlet conditions closer to the boiling point.

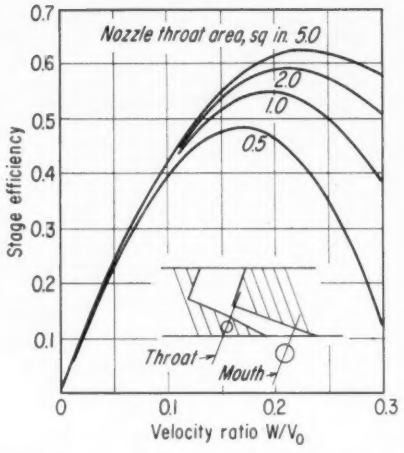
Now let's see how suction problems differ when the source is below the pump. By theory the maximum lift at sea level is 33 ft (60 F and atmospheric pressure). Piping, entrance and velocity losses cut this some. High-altitude installations (Denver) cut it more. And if the water is heated above 60 F the maximum lift is even less.

Lift service factor is just as vital as that needed with the tank over the pump since water is lifted from an open tank by reducing pressure in the lift or suction line. As the line pressure drops, air in the water expands, increasing the gas volume the pump must pass. Water at 80 F and atmospheric pressure will hold about 2 cu ft of air for each 100 cu ft of water. For a 20-ft lift the pressure drop in the line (to 12.35 in. hg) permits a gas expansion of over twice the original volume.

Since expansion occurs in the suction line, unless you provide an air receiver near the pump inlet, you might end up with an airbound pump.



1 Representative curves for nozzle-and-bucket efficiencies of 1-, 2- and 3-row wheel impulse stages and for the single-row 50% reaction wheel all peak at one speed ratio



2 Typical stage efficiency: 25-in. pitch dia 2-row wheel, 0.72-in. reamed nozzles

Knowing the function and behavior of parts of a machine lays the basis for predicting how they will work together in determining the overall performance of the unit

How to figure m-d turbine power

By A H SISSON, Manager, Thermodynamic Design,
Small Steam Turbine Dept, General Electric Co

We have studied the principal elements of a turbine and learned how each affects the overall performance. Fig. 1 shows how the combined bucket and nozzle efficiency varies with velocity ratio for 1-, 2- and 3-row impulse wheels and a 50%-reaction 1-row wheel. The reaction wheel is seldom used in m-d turbines.

Greatest number of 2-row wheels are in 1-stage turbines, but they are also used in 2- and 3-stage turbines for condensing and noncondensing operation up to 1000 hp at speeds of 6000 rpm and lower. Two-row wheels are used in the first stage of multistage turbines where best efficiency is not paramount. The 2-row wheel can lower the stage pressure enough to permit using thinner shells and flanges. The lower efficiency is partly offset because the steam reheat can do more work in the lower stages.

Fig. 2 shows how the throttle area of the nozzles affects peak efficiency in respect to the velocity ratio. These curves apply to 2-row wheels.

Nozzle areas can be calculated from the formula:

$$F = CAN\omega \qquad (1)$$

where F = flow of steam, lb per hr
C = nozzle flow coefficient
A = nozzle area, sq in.
N = restriction factor, Fig. 4
$\omega = K\sqrt{P_1/v_1}$ where constant K depends on the elastic fluid, P_1 is the nozzle inlet pressure, psia, and v_1 the inlet specific volume, cu ft per lb.

At constant initial enthalpy ω is nearly proportional to P_1; in Fig. 3 we plot ω/P_1 against enthalpy for convenience and then write equation (1) as:

$$F = CAN(\omega/P_1)P_1 \qquad (2)$$

Then nozzle area can be found from:

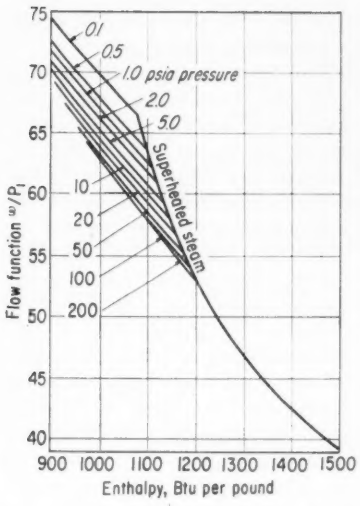
$$A = \frac{F}{CN(\omega/P_1)P_1} \qquad (3)$$

Applying this to a 300-hp 1-stage turbine needing 25,000 lb per hr of 200-psia steam with 1199.0 Btu per lb enthalpy we assume a reasonable flow coefficient of 0.95 and nonrestricted flow, N = 1.0. This turbine needs a total nozzle area of:

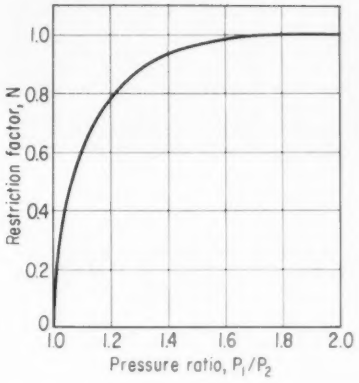
$A = 25{,}000/(0.95 \times 1.00 \times 53.1 \times 200) = 2.48$ sq in.

Where the ratio 53.1 was found from Fig. 3 corresponding to 1199.0 Btu enthalpy and 200-psia pressure.

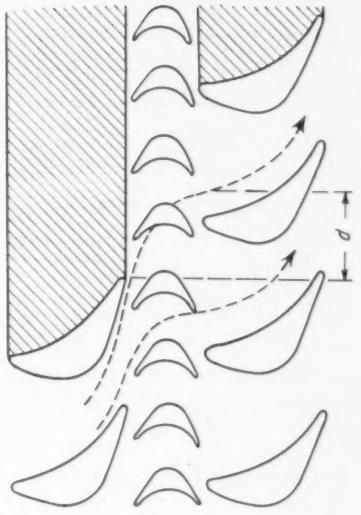
Restriction factor, N, corrects



3 Flow function curves vary with the enthalpy and pressure at initial state



4 Restriction factor corrects flow equation for pressure ratios below critical



5 Nozzles of following stage must be placed to receive steam from buckets

the nonrestricted flow formula for pressure ratios less than the critical pressure ratio. Fig. 6 shows the condition that causes reduced flow. Nozzle A of fixed area receives steam (or gas) at fixed pressure P_1; when valve B is closed $P_2 = P_1$ and there is no flow. Opening valve B (connected to a vacuum) lowers P_2 and increases flow through A until a critical pressure ratio $P_1/P_2 = 1.83$ is reached; further reduction of P_2 does not further increase the flow through A. The flow is called nonrestricted at pressure ratios higher than the critical.

Flow coefficients, C, vary from 0.8 to 0.97 with extremes of pressure ratio and velocity ratio. For normal loads, 1-stage turbines and first stages of multistage turbines will have these coefficients:

Stage type	*Apparent C*
Single-row	0.93 to 0.97
Two-row	0.91 to 0.95

These are called apparent C's because they may include some restriction effects. Under some conditions there may be a pressure drop in the flow through the buckets.

Residual velocity. In Part 1, POWER, Nov 1958, p 86, Fig. 1, we saw that the steam leaves a bucket with a residual velocity V_x. This kinetic energy can be used in the following stage if its nozzle is properly designed. For full arc stages closely stacked and no more than about 25% height increase in the following stage, the work output can be raised as much as 3% by using incoming residual velocity.

For partial arc stages we must rotate or advance the nozzle area of following stages by some distance d, as in Fig. 5, to properly receive the steam flow. Any error in rotation lowers overall turbine efficiency.

Partial arc arrangement raises the problem of the inactive arc of buckets churning the steam trapped in the area. This rotation loss can be reduced as much as 50% by shielding the inactive arc, Fig. 7.

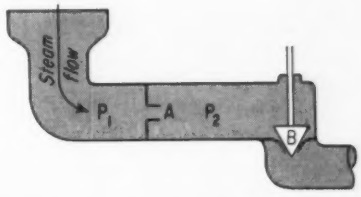
These shields reduce the total volume of steam in the inactive area. The same effect may be realized with closer stacking of the diaphragms.

Packing leakage loss. We can figure steam flows through packing clearances by equation (2). The annulus area can be figured by:

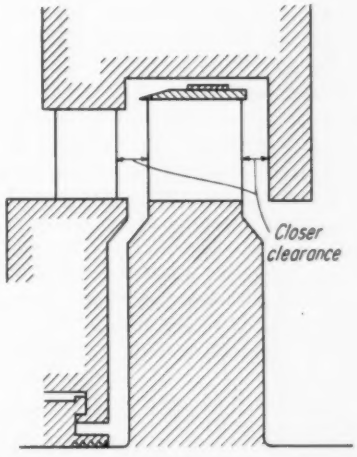
$$A = \pi D C_1$$

where D = clearance diameter, in.
C_1 = radial clearance, in.

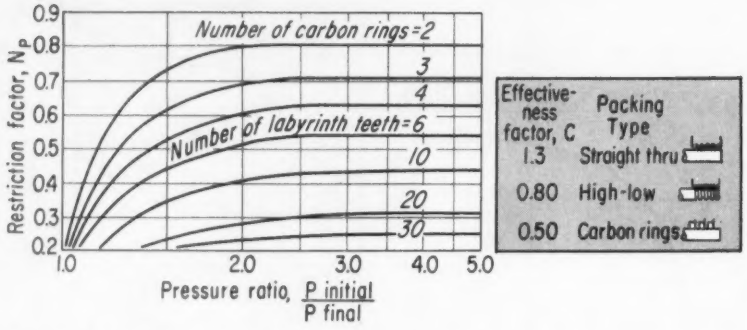
The packing teeth form a series of orifices that give a series of smaller pressure ratios that combine to make the overall pressure ratio for any given flow. Fig. 8 gives values of



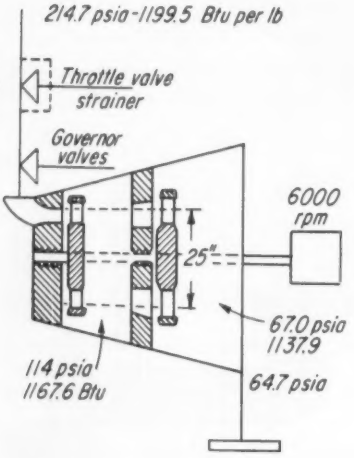
6 Experimental setup for relating restriction factor to the steam pressure ratio



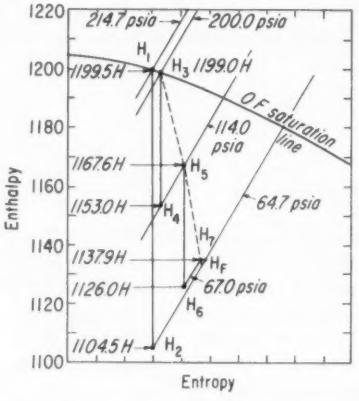
7 Shields over buckets passing through inactive arc reduce the rotation losses



8 Steam flows through shaft packing clearances may be calculated by using above restriction factors, N_p, and the effectiveness factor C for type of packing used



9 2-stage turbine takes saturated steam at 200 psig, exhausts it at 64.7 psia



10 Expansion line of a 2-stage turbine shows change of state of steam flow

N_p that should be used in place of N in equation (2), and also the flow coefficients for each type of packing.

Example: Find the leakage through a labyrinth packing of the straight-through type with 20 teeth for a 6-in. dia shaft with 0.010-in. radial clearance when initial pressure is 114 psia, enthalpy is 1166.0 Btu per lb and final pressure is 14.7 psia.

$$P_1/P_2 = 114/14.7 = 7.75$$

From Fig. 8, the pressure ratio is off scale but the horizontal curve shows that for ratios greater than 5.0, $N_p = 0.310$. From the table in Fig. 8 find $C = 1.30$.

From Fig. 3 find ω/P at 1166.0 and 114 psia = 54.8.

Then $F = 1.30\ (3.14 \times 6.0 \times 0.010)\ 0.310 \times 54.8 \times 114$
$= 474$ lb per hr

Packing leakage must be piped to some lower-pressure stage in the turbine or drained to some convenient sink in the heat balance. Severe interstage packing leakage can reduce turbine-shaft output, particularly on small turbines. Leakage may also raise the thrust load since the higher flow must discharge through the balance holes in the wheels and through the clearance areas near the bucket roots. Higher pressure on the upstream side of this flow raises thrust.

Figuring turbine output. Let's run through an example of how to calculate turbine performance for given steam conditions. Fig. 9 shows the schematic arrangement of a 2-stage turbine with 25-in. pitch diameter and single-row wheels. The turbine running at 6000 rpm takes 33,000 lb of 200-psig saturated steam and exhausts it at 64.7 psia.

From steam-rate tables we find that the TSR for the turbine is 26.8 lb per hphr. Since 2544.1 Btu equals 1 hphr we can figure 2544.1/26.8 = 95 Btu per lb of energy given up by the steam. For study we plot these conditions on a Mollier diagram in Fig. 10. This shows that an isentropic expansion from 214.7 psia gives available energy of $h_1 - h_2 = 1199.5 - 1104.5 = 95.0$ Btu per lb of steam.

The steam drops to 200 psia at the first-stage nozzle inlet and it has a radiation loss of $h_1 - h_3 = 0.5$ Btu per lb. This gives us 1199.0 Btu per lb at this state, h_3.

An isentropic drop or expansion from h_3 to h_4 at 114.0 psia gives us 1199.0 – 1153.0 = 46.0 Btu per lb available energy in the first stage. We have arbitrarily divided the overall pressure ratio 200/64.7 into two equal pressure ratios of 1.76 for the two stages. This may not give us the best shell pressure for the first stage, but we won't show how this is found.

Returning to the 46.0 Btu available energy, we know we can't convert all of this to shaft output. For these conditions we will have a supersaturation and moisture loss of 2.6%; or $46.0(1.000 - 0.026) = 44.8$ Btu per lb to do work in the stage. We know this stage will have an efficiency of 70%, so the used jet energy will be $44.8 \times 0.7 = 31.4$ Btu per lb, leaving 14.6 Btu in the steam unconverted to shaft work. This gives us 1153 + 14.6 = 1167.6 Btu per lb entering the second-stage nozzles, h_5.

Isentropic expansion from h_5 to h_6 at 67-psia exhaust-casing pressure (cf with 64.7-psia line pressure) gives us 41.6 Btu per lb available energy. Correcting for moisture and supersaturation losses we reduce this to 39.6 Btu. At 75% stage efficiency we get 29.7 Btu converted to shaft output. Then steam enthalpy at exhaust is figured as 1126.0 + 41.6 – 29.7 = 1137.9 Btu per lb.

First-stage wheel output is = 33,000 × 31.4/2544.1 = 406 hp. Second-stage wheel output with 400 lb per hr gland leakage figures out to be = (33,000 – 400) 29.7/2544.1 = 380 hp. Subtracting 1.7% for mechanical losses we get total output = (406 + 380) 0.98 = 773 hp. This gives a steam rate of 33,000/773 = 42.7 lb per hphr for the turbine unit.

How important is lube life?

Many plant engineers fail to recognize the growing importance of lubricant life—and not simply as a means to trim their lube bills. Here's the reaction we got to questions asked of field experts...

By JIM FOLLANSBEE
Assistant Editor

Q. Why is lubricant life more important today?

A. Mainly because of labor saving says the user, and the oil supplier agrees. Even though automatic lubrication has come a long way, there are plenty of bearings and gear housings that need manual lubrication. Stretching the time between lube applications here can save the user real money.

Q. What about lubricant cost—is it important?

A. Yes, but not as important as the labor saving. The oilers' payroll in at least one plant is two-thirds higher than the lubricant bill, and that doesn't include storage and handling costs.

Q. How do you go about boosting lube life?

A. First, get some basic data from the oil suppliers and equipment manufacturers on lubricant life under good operating conditions. Dig back into your plant records and check lube schedules for your actual working conditions. Cross check lubrication frequency in the different areas of your plant to see if bearings and gears working under similar circumstances are getting the same treatment. Talk the problem over with engineers from other plants with the same problem.

Tie all this information together and judge for yourself what your frequency rates should be. Stick in a safety factor and don't double the rates right off the bat; take it in steps.

The oil supplier goes along with this approach, stressing the caution needed. A program designed to extend application periods on a large scale in a plant needs close supervision since the trouble caused by oversights will cost more than the saving in lubes and manpower.

Q. What are some of pitfalls in extending lube life?

A. Parts failure. Oil and grease breakdown caused by overwork leads to serious repair bills.

For example, in a recirculation system, oxidation brings on deposits which can clog lines or filters, resulting in reduced or cut off oil supply. Recirculation oil systems have a twofold purpose—to lubricate and cool. Cutting down lube flow might not hurt lube action, but reduced cooling effect can have fast, serious results.

Leaving oil in too long increases viscosity and boosts heating of the parts. Also, chemical reaction rates double every 18 F rise, and experimenting with a high-temperature application is risky.

Q. How can you check on lube performance?

A. If it's an oil, you can have it analyzed. This is costly, but about the only sure way to tell if oil is breaking down. Visual inspection of many oils won't tell you much until it's too late.

With greases, just looking at them will usually let you know whether they need to be replaced. They turn dark, get stiff and may show a separation of the oil and soap.

Q. What do you check before changing frequency?

A. If high temperatures, moisture or leaks are causing frequent lube applications, there isn't much point in doing anything until these troubles are cleared up. Often the choice of a different grease may give you longer life automatically, since it will resist the effects of moisture or heat.

Q. Where has extending lube life paid off?

A. The user we talked with got the best lube frequency change with motor bearings, pillow blocks and gear housings. User greases his motors and certain pillow blocks once a year and that's it.

He uses the expendable theory on some pillow blocks figuring that it's cheaper to replace them now and then rather than to lose product because of over greasing.

Oil supplier believes rolling-contact bearings and gears are easier places to extend lube life than sleeve bearings. He says having an all-loss or recirculating varieties to do the job.

Q. Are there any new greases or oils on the market that promise longer life?

A. Both user and oil supplier say "yes." User has switched over to EP grease entirely for all but the very special applications, allowing them to use one grease now where it previously took six different varieties to do the job before.

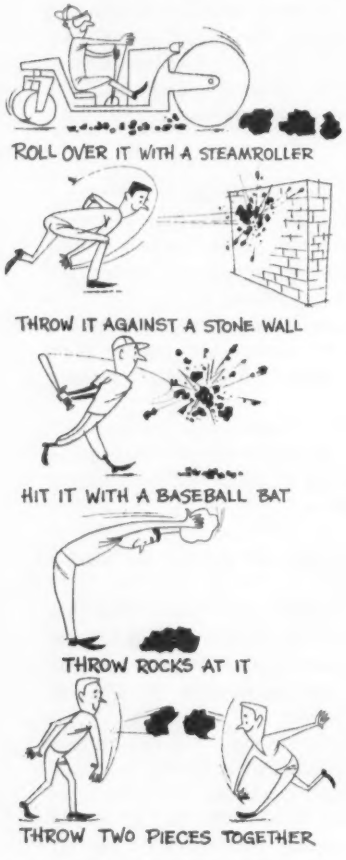
These greases cost more than ordinary grease but they cut oiler mistakes since there's only one grease to use. They have a tougher film, giving an added operating safety factor. As far as giving longer life, the oil supplier says the EP's can do two jobs: (1) Tackle the tough assignment and extend frequency rates from, say, once a day to once every three days. (2) Replace many types and do a good job over a wide range of applications. Either way the user can cut both his lubrication bills and the time needed for the oilers to do their job.

By R G ELMENDORF
Majac Inc, Pittsburgh, Pa.

New developments in firing and increased interest in burning low-grade fuels point up . . .

Why pulverizer design needs updating

Five ways to grind coal


ROLL OVER IT WITH A STEAMROLLER
THROW IT AGAINST A STONE WALL
HIT IT WITH A BASEBALL BAT
THROW ROCKS AT IT
THROW TWO PIECES TOGETHER

Coal can be pulverized in five ways. One is primary in pulverizing done by today's mills. Other influences may play a part, but as secondary effects

Since pulverized-coal firing was introduced about 40 years ago, the pulverizer's dependability has been a key factor in the development and widespread use of this firing method.

Today, however, coal pulverizers need improvement. True, this is a challenging statement. But new developments in firing methods (for example, the cyclone furnace) and increasing interest in low-grade fuels have put the pulverizer in a competitive position that's far more challenging than mere competition existing between makers.

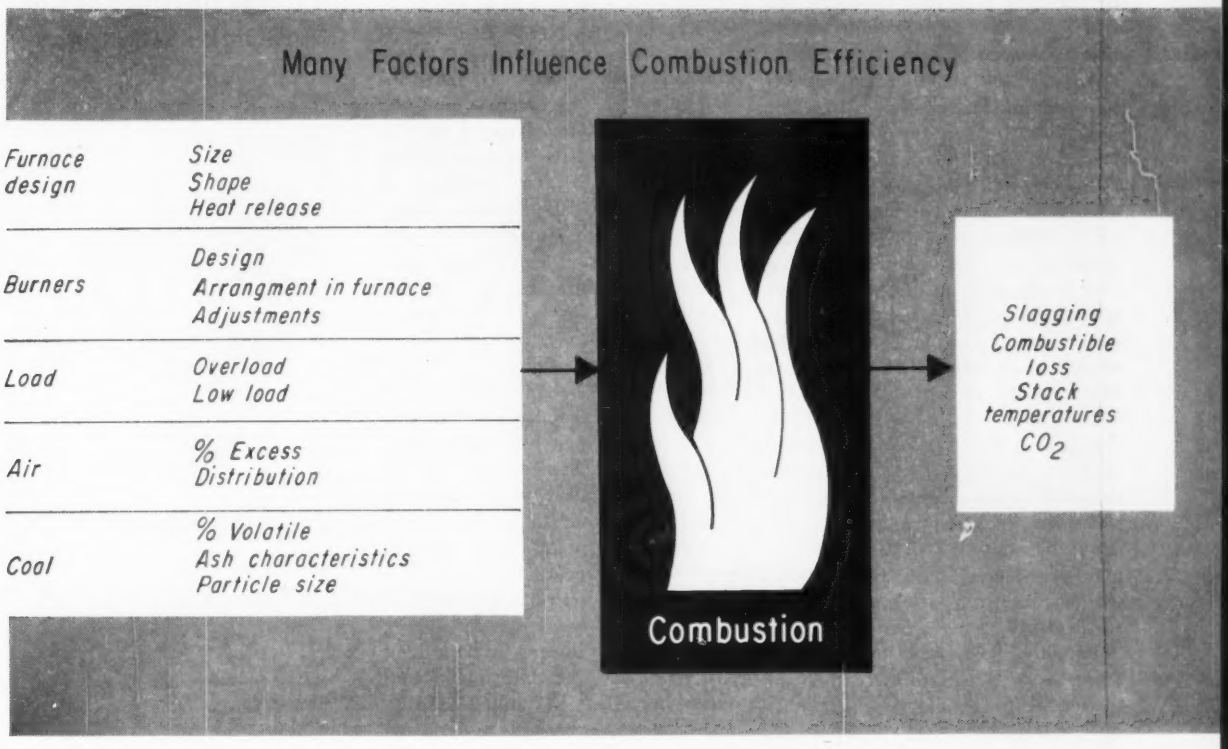
Increasing recognition of the pulverizer as a separate, *but not necessary*, unit in the combustion process focuses much attention on this piece of equipment. The spotlight reveals that further developments in both design and use should be made to meet the challenge. Manufacturers should be willing to make the necessary design changes. Users' policies on purchasing, engineering and testing pulverizers can help to encourage this. Result would unbalance the somewhat "static" position of today's mill manufacturers. Not only bigger mills (being developed today), but *better designed* mills are needed.

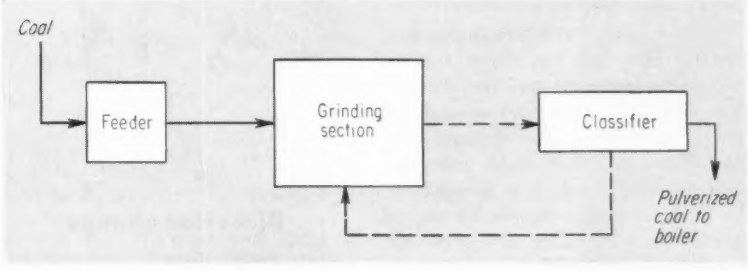
To harbor the idea that the pulverizer is just a minor adjunct to the boiler and not worthy of separate attention is to ignore the fact that about 2½% of plant cost is tied up in pulverizers. Further, about 10% of plant maintenance is spent on pulverizers and approximately 1% of energy generated by the plant is used by pulverizers. More improvement than is generally suspected can be made in these costs by taking a hard look at the pulverizer for what it is —a separate unit in the combustion process. Let's examine some basic areas in which pulverizers and engineering associated with their use can be improved:

Classifiers. Here is an area which deserves much closer attention by the user because the source of many combustion troubles in the boiler can be traced to the mill classifier. Classification of the coal fired has a definite effect on combustion.

Traditional factors of good combustion are time, temperature, turbulence. Now, let's add a fourth factor —particle size. The coal must be fine enough to burn completely in the time and temperature allotted to it. Less time and temperature available, finer the coal must be to burn completely; more time and temperature available, coarser the coal can be and still burn. It follows that combustible loss, furnace size and soot-blowing requirements are all as dependent on particle size as they are on the traditional factors. Normally the total effect on combustion efficiency of burner and furnace design, excess air, load conditions and coal characteristics tends to disguise the effect of good or bad pulverizing. For example, it's possible to trade fineness for greater slagging and get the same boiler efficiency.

Particle size specified for the coal determines the job that the classifier must do. Ideally all particles would be exactly the same size, so they'd





COAL-FLOW CONTROL, classifier design, determine particle size band produced by the classifier. Many combustion troubles can be traced to inefficient classifier output

burn in exactly the same time and in the same manner. But in actual practice a classifier produces a band of particle sizes.

Today's general specification of 70% through a 200-mesh screen means little. It doesn't limit top size of particles, nor does it limit number of particles near top size. And it's these coarse particles that cause trouble. Plus-50 mesh are undesirable in any furnace; plus 100 are undesirable where furnace overload conditions exist.

Secondary defect of this spec is that it doesn't limit fineness of particles passing through the 200 mesh. This permits overgrinding and higher-than-necessary energy consumption.

Good classification should narrow particle size band and hold it at best value for the boiler at the moment. If specs relating to particle size are to be of value, they should show percentage of material retained on 50-, 100-, 200- and 325-mesh screens.

Mill classifiers are usually built integrally with the pulverizer itself and, by reason of compact design, are very small. Drawings, p 74, show the most widely used classifier designs. In the majority of cases, design follows the centrifugal force (cyclone) principle. This is modified to fit the particular space limitations and arrangement of the mill involved. The modifications distort the cyclone from its ideal design shape and tend to upset proper flow in the cyclone because of the method of admitting the coal-air mix. Inefficient classification often results. There's also a question of whether a cyclone, even an ideal one, can satisfactorily keep particle size band narrow enough for most efficient grinding and the best firing.

Coal flow control method used with the mill has an important effect on the classifier. Standard method is to vary primary air flow through the mill in response to load change. This is sometimes accompanied by a change in coal feed, either directly or in response to coal load in the mill. With this system of varying primary air, a constantly changing air volume passes through the classifier.

Coal particle size that is accepted by the classifier and leaves the mill depends on three influences: (1) air volume (2) coal-to-air loading (3) design and settings of classifier. Consequently, with a control that varies primary air, fineness of coal ground

by the mill constantly changes. Effect on slagging and combustible loss due to this unstable fineness characteristic of the classifier is probably to accelerate difficulties.

Primary reason for air variation is tied up with the coal load in the mill. The mill's fast response to the combustion control's signal is desirable. With a mill having a slow grinding rate, or a large circulating load in the mill at all times, this response must be secured by utilizing partly ground coal in the mill. Thus when a load increase calls for more fuel, primary air increase sweeps the mill of all available particles. It's at this instant that particle size control is lost. A pulverizer that permits constant control over particle size, regardless of load, would be a welcome development. A classifier which permits the operator to vary particle size at any time *from the control room* would be much better.

Potential advantages of fine-grind firing are attracting increasing attention. Improvements to be expected in furnace design and combustion efficiency indicate that the classifier of the future should be designed to handle very fine grinds. Applications such as the supercharged boiler and the coal-fired gas turbine may require a 5-20 micron particle size.

Testing. Adequate sampling of coal, the pulverizer's product, is essential in rating the unit. Today's methods for sampling coal leaving the mill seem to give widely divergent results. A simple means of sampling coal would be a valuable aid toward better combustion.

Coal's hardness or "willingness to be ground" also is important. Grindability measurements are commonly used today. However the standard grindability testing machine (Hardgrove) gives results that are applicable only to ball or bowl mills and have little relation to impact or attrition mills. Here, again, an instrument to measure friability (tendency of pieces to shatter on impact) would be a boon to the pulverizer user.

Economics of pulverization could bear closer study today. It should be recognized that true pulverizing costs include more than capital investment, power input and maintenance. Evaluation of the probable effect of grinding differences on soot blowing and combustible loss should be included. Price of heat energy in the primary air to the mill should be included. Capital cost of facilities for supplying power to the mill should be added. Credit should be taken for addition of useful heat to the coal, air and moisture in passing through the mill. The best way to evaluate the pulverizer's true energy costs would be by means of an energy balance. This would be no more difficult to achieve than an analysis of the heat cycle—and it's just as important.

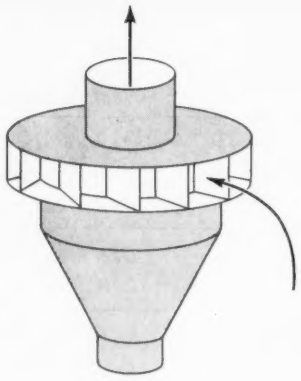
Comparison. Pulverizer capital-cost comparisons should be based on *demand* tons (the boiler's actual peak needs, in tons per hr) rather than *installed* tons. Number and size of pulverizers installed on a particular boiler vary widely today and a certain amount of excess mill capacity is provided in every case. Amount depends on (1) pulverizer sizes available (2) number of mills matching best with the burner arrangement (3) frequency and duration of mill outages expected (4) mills' capacity decline from wear (5) boiler's expected peak coal demand and (6) user's individual policy.

Excess capacity varies from 5 to 40%, depending on these factors. Economic comparisons based on total installed tons take no account of these differences. The *demand tons* basis, on the other hand, takes excess capacity needs into account.

Maintenance. Successful use of low-grade fuels, such as lignite and coke breeze, depends heavily on reducing pulverizer maintenance. Consequently, improvement in existing mill designs and development of mills which will reduce maintenance are being watched intently. Maintenance cost is more important than any other pulverizing cost in the sense that while capital investment is spent at a fixed interest rate, and power cost is relatively stable, maintenance cost trends upward because of increased cost of labor and parts.

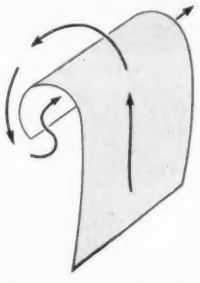
Every pulverizer needs maintenance. Just as important as low mill maintenance is recognition early in the plant design stage of the *need* for maintenance and providing adequate elbow room, tools and facilities for carrying out the work. If maintenance costs are compared with other plants, the basis of costs should be established on an equal footing.

Typical classifier design principles used today



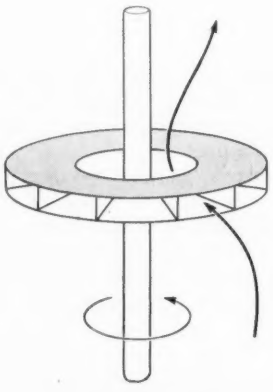
Cyclone

High-sided internal-cone unit with adjustable vanes rejects discharge at bottom



Direction change

Coal-air stream's sharp direction change in classifier throws out oversized particles



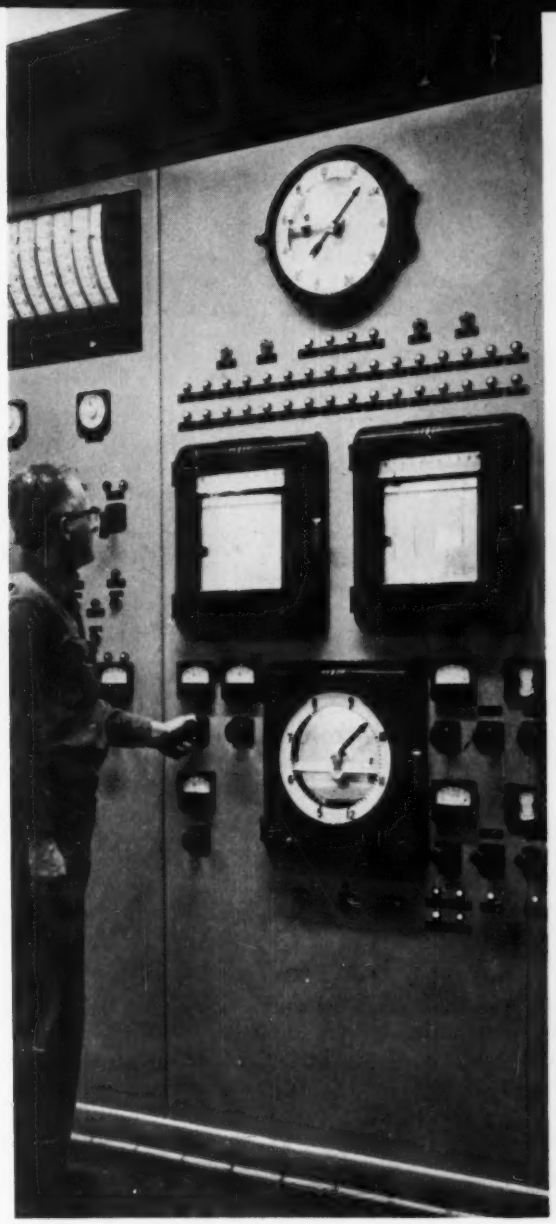
Power driven

Larger particles are rejected because they're caught by rotating element's blades

Local receiver-controller system reduces time lags

By C S BEARD, Chief Engineer, Valve and Actuator Div
General Controls Co

Control system dynamics continually improve to answer the call for faster, more accurate response. Here is a system that cuts time lag and may do your control job for less money

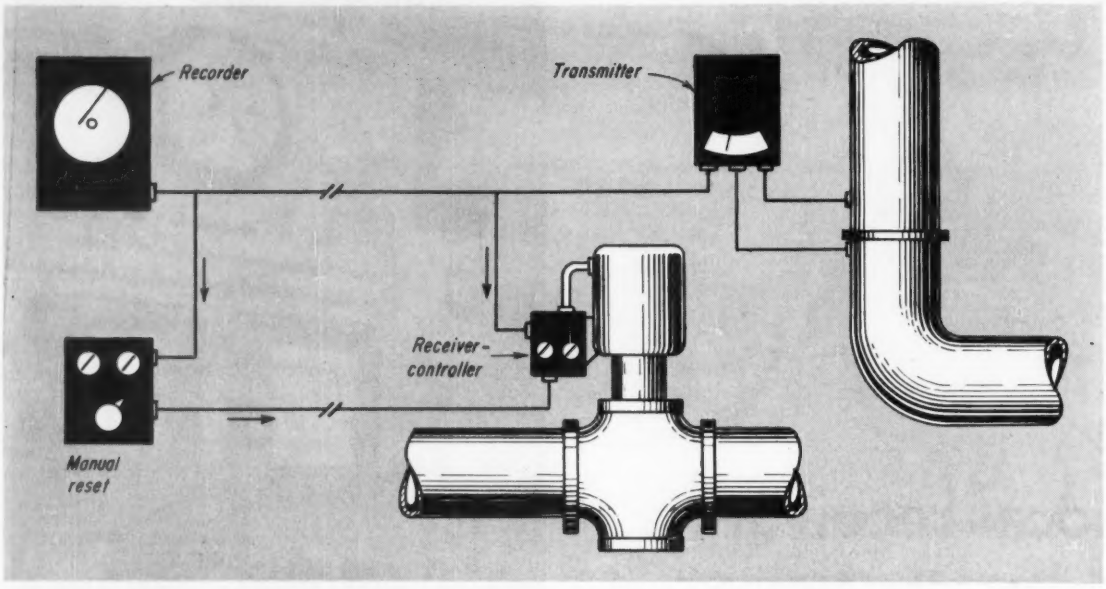


OPERATOR CONTROLS remote operation from standard panel. Author's system can cut time lag in this and other operations

Today's power-service systems are so big operators often can't go to a point of measurement. With increased distances it becomes difficult and sometimes inaccurate to pipe a variable such as pressure to a convenient instrument location. Many measurements such as boiler feedwater conductivity, flue-gas analysis, stack temperature, water level or fan speed must be taken locally—a big reason for the gain in popularity of pneumatic or electrical transmission. Here, measurements made locally are transformed into a pressure or electrical impulse. The receiver indicates or records the impulse on a scale calibrated in terms of the instrument range. This reading more truly reflects the variable with less lag between the instantaneous value and the reading.

Receiver may be a controller, too. If so, controller must deliver an impulse to an actuator that positions a valve or other control device. Thus transmission back and forth increases the time lags depending upon distance to the actuator and various constructional features.

For years we have had components for a control approach that eliminates many disadvantages of placing control mechanisms at remote, although convenient, points. Our system consists of a pneumatic transmitter and a receiver-controller integrally mounted on the actuator. The controller puts out a varying pressure to position a pneumatic actuator, just as many other controllers would do. But it also reacts to an air pressure signal from a pneumatic transmitter. These pneumatic transmitters then measure a variable like speed, pH or pressure and deliver an air pressure directly propor-



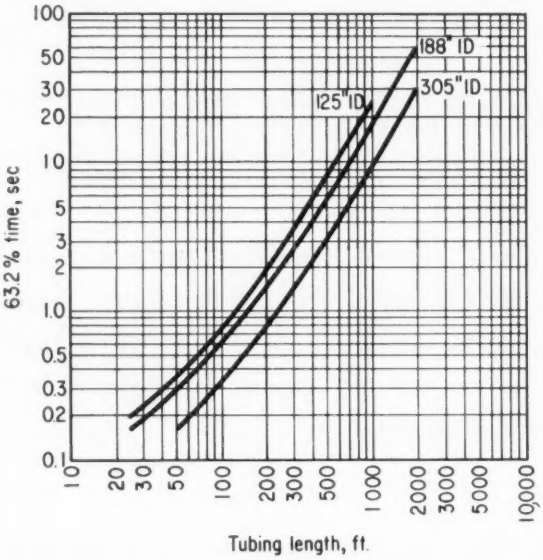
LOCAL RECEIVER-CONTROLLER in metering system mounts directly on flow control valve. Differential pressure transmitter delivers signal exactly proportional to flow for recording and control action. Eliminating extra tubing reduces system time lag

tional to the variable. An accepted transmitter output range is usually 3 to 15 psig. A matching receiver with 3 to 15 psig input can be adjusted so nominal set point is at mid range.

In this system the transmitter is installed at the point of measurement to decrease lag as much as possible. We've found correct placement of the transmitter decreases lag in static lines for flow, pressure or differential pressure applications to a negligible amount compared to other lags. However, measurement lags in temperature systems are not increased or decreased appreciably by transmitter location because of large time lag inherent in use of thermowells. Most transmission systems for sampling pH, flue gas or specific gravity are improved by short sampling lines.

Extensive tests have been made to evaluate lags in transmission systems as well as their effect upon the control loop. A step upset causes a lag between a transmitter and receiver that varies with magnitude of change, mean operating pressure, length and size of tubing, direction of change and volume of receiver element. Since transmitter characteristics affect time constants, most tests are run by pressure from a tank which can be considered as infinite capacity.

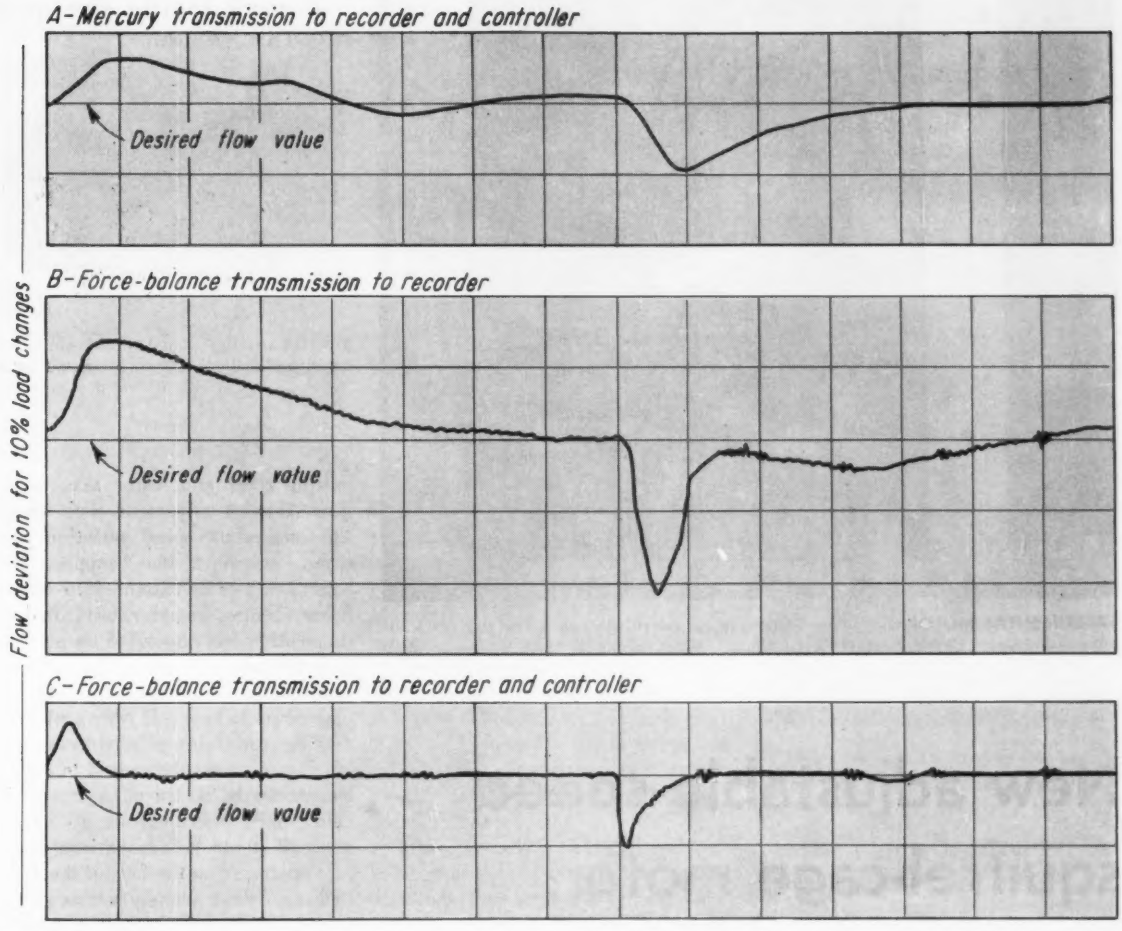
Probably the most useful test using the step upset approach is represented, right, as the time lag for different sizes of copper tubing over varying lengths. The 3 to 15 psig change gives a maximum effect so it is most valuable. Various tests were run to show effect of transmission line length upon control stability. These tests used rapid load upsets and also sinusoidal upsets at various frequencies. The curves emphasize the desirability of decreasing transmission lags—which can be done using the transmitter, receiver-controller tech-



TUBING RESISTANCE slows system response to step upset. Time needed to build up to 63.2% of maximum upset is relative index

nique. A system showing excellent control with 200 ft lines becomes difficult with 600 ft lines. Longer lines continue upset at a low level for an unreasonable time.

Speed of response and sensitivity of the transmitter itself cannot be disregarded even though the system under discussion decreases the effects of measurement or transfer lag. Flow control offers a good example because flow differential transmitters vary so greatly in speed of response. A bellows or diaphragm move-


A-Mercury transmission to recorder and controller
Desired flow value
B-Force-balance transmission to recorder
Desired flow value
C-Force-balance transmission to recorder and controller
Desired flow value
Flow deviation for 10% load changes

CONTROL ACTION for three systems emphasizes rapid-response transmitter's advantage. Curve *A* shows mercury manometer's damped signal, force-balance unit transmits true fluctuations in *B*. Signal transmitted, as in *C*, to controller speeds system response

ment reacts faster to differential change than a float or one leg of a mercury manometer. Curves, above, present results of a test to show effect of low response speed and low sensitivity of flow transmitter on measurement as well as control.

Many variables, flow included, could be held much closer to constant values if controls corrected simultaneously with deviation from set point. Although advances have been made in transmitter measuring methods, development has not kept pace with advances in dynamic characteristics of controllers and actuators.

Innumerable combinations of transmitter - receiver equipment are possible, depending on what must be done. Simplest approach is a transmitter that delivers pressure to an integrally mounted receiver-controller equipped with manual set-point adjustment.

Ratio relay may be employed as a transmitter for control of high pressures with ratios as high as needed. At a 1:1 ratio, relay isolates the control system from viscous or corrosive fluids and may correct liquid head variations.

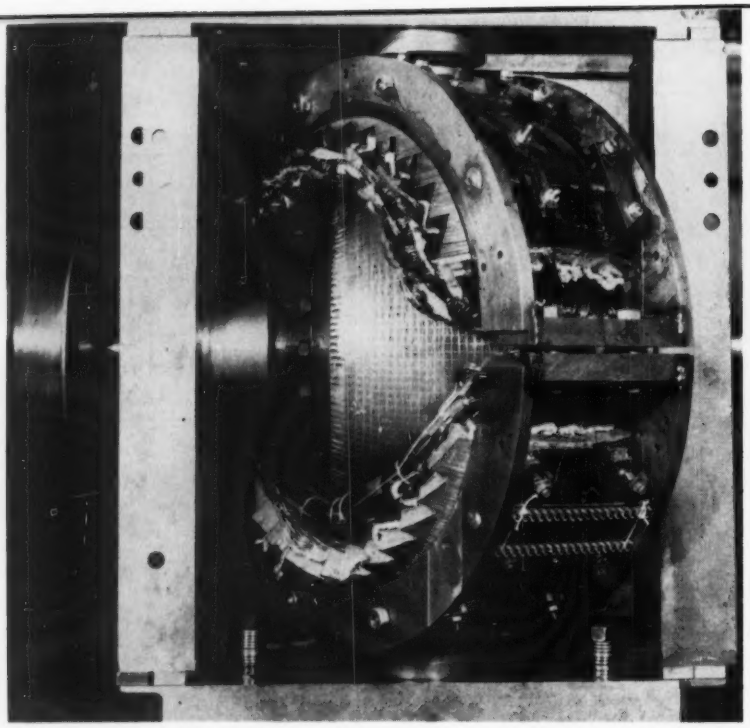
Now that we have studied control characteristics we can look at a few specific applications for this system:

(1) Fuel oil lines may require transmitters for usually remote temperature or pressure measurements. Fuel oil viscosity dictates close coupling of transmitter.

(2) Differential pressure transmitters team with receiver controller for liquid-level control which eliminates hysteresis found in float actions. As time charts above point out *D-P* cells are also ideal for metering control of boiler or process flows.

(3) Instruments measuring density of liquids or specific gravity of gas must be installed close to the sampling point. Measurement lag, as well as pressure loss with long sampling lines, contributes to this requirement. Transmission directly to receiver-controller reduces the control system lag to a bare minimum.

These examples of transmitter, receiver-controller systems should bring to mind other control problems throughout your plant. Use the system if you can improve stability by decreasing lags in measurement, pressure output transfer or actuator dynamic response. Also use this method if unit and piping cost is less than more involved systems that might give the desired results.



EXPERIMENTAL MOTOR shows how stator can be moved through a few degrees while rotor is turning. Bearings are held in frame. Stator pivots at right angles to shaft

New adjustable-speed squirrel-cage motor: what does it promise?

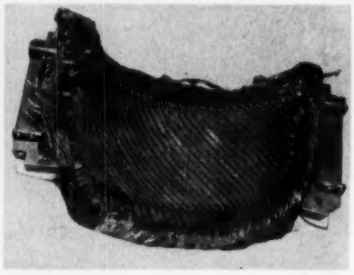
Today's automated processes give big incentive to design new adjustable-speed ac motors. Of those being developed, most depend on rectifying or commutation. Now along comes a model that works on a new principle

By Dr E R LAITHWAITE, Manchester University, England

A squirrel-cage induction motor with speed that can be adjusted continuously without an additional regulator or resistor has been invented by Prof F C Williams and myself at Manchester University, England. Although it's still in the development stage, the new design holds out several advantages over familiar adjustable-speed machines. Big feature is simplicity of installation and maintenance. Electrically it's almost as simple as a constant-speed squirrel-cage motor; mechanically it's less complicated than motor-driven mechanical speed changers.

Stator bore and rotor core are spherical rather than cylindrical, permitting rotor and stator axes to be inclined with respect to each other. This makes the speed variation possible. Bearings that support the rotor are rigidly mounted to motor frame. Stator, however, is pivoted so its position can be shifted on an axis perpendicular to axis of the rotor.

A look inside the new



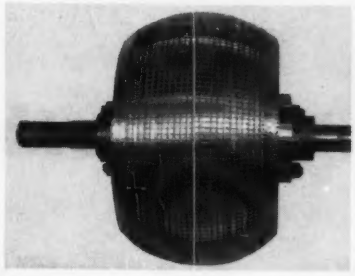
STATOR has two wound blocks which are keyed and bolted into place around rotor

Principle of operation is explained as follows: If a disk of conducting material is pivoted at its center, Fig. A, it can be caused to rotate by action of a traveling magnetic field. Such a field is set up by an array of stator coils in an iron structure operating on the face of the disk. In Fig. A the traveling field is represented simply by alternate N and S poles traveling in direction of the arrow. Speed v_s of such a field is given by $v_s = 2\,pf$, where p is pole pitch and f is frequency of supply.

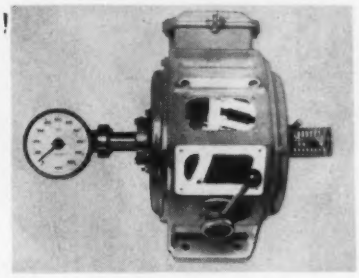
If the stator block is situated at a mean radius r, Fig. A, the rotational speed is v_s/r radians per sec. It can be seen that the disk speed can be adjusted by moving the stator block to a different radius. But instead of "bodily" moving the block along a radius, it can be rotated to position shown in Fig. B where the velocity vector is, as it were, aimed at the smaller radius r'. Thus field velocity at a is directed at an angle θ to disk velocity, as shown in the diagram.

It has been shown theoretically and verified experimentally that the ideal running-light speed of the disk is the same as it would be if the stator block were displaced physically to the position shown by dotted lines. In other words, by constraining conductor to move in a direction making an angle θ with direction of

motor shows the spherical stator and rotor



ROTOR has numerous circumferential rings that permit it to conduct in any position



ASSEMBLED MOTOR has handle to shift stator, change speed. Lock holds it there

the field velocity, v_s, the synchronous speed is raised to a value $v_s/cos\ \theta$.

The principle is explained more generally in Fig. C. If the conducting material is allowed to move with the field array in direction PP', the effective pole pitch is oa and the conductor running light should move from o to a in ½ cycle. If, however, it is constrained to move along QQ', it can theoretically move from o to b in ½ cycle, the effective pole pitch now being $ob = oa/\ cos\ \theta$.

In practice, the new principle can be used only when (1) the rotor is capable of conducting in all directions, and (2) the poles of the stator are wide compared with the pole pitch. Regarding point (1), the current configurations set up in the rotor must be in the form shown in Fig. D, no matter what value of θ is chosen. Therefore the rotor must at least approximate a conducting sheet. The spherical rotor, photos above, approximates this condition while retaining advantages of typical cylindrical rotors.

Spherical rotor consists of laminated iron carrying a lattice of conducting bars and rings. With many bars per pole pitch, the rotor surface behaves much like a conducting sheet. Inner surface of stator block is spherical and concentric with the rotor. The stator block can be adjusted to any value of θ less than 90 deg.

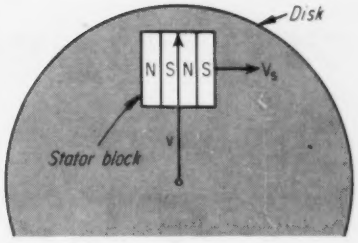
Experimental machines have been built with a rating of about 10 hp. Efficiencies of over 70% on a 1.5:1 range (300-450 rpm) or 60% on a 2:1 range (200-400 rpm) have been achieved with this size. Efficiency varies only 1 or 2% over entire speed range. Photo, above right, shows a demonstration model built by Metropolitan Vickers Electrical Co Ltd. Machines of 200 and 500 hp are in process of design and construction.

Advantages of the spherical motor are: (1) It's self-contained. (2) It has no brushes or rubbing contacts. (3) Rotor construction is robust. (4) It has a high power weight ratio compared with other adjustable-speed drives.

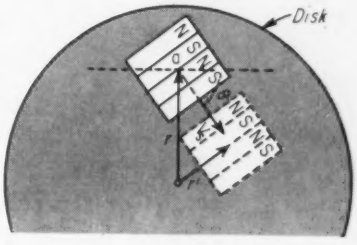
Spherical motors have highest efficiency at slow speeds, implying that they may find widest usage for slow high-power drives. Early experiments showed this type of motor differs considerably from conventional machines in other respects than its variable-angle property. In particular, when the angle θ was made zero, an analysis of losses showed a source of loss in the vicinity of small slip values. Analysis of flux patterns shows that the extra losses fall from a maximum at synchronous speed to zero at a slip of $1/(n + 1)$, where n is number of poles on stator block. Rotor efficiency is, therefore, limited to $1/(n + 1)$, and it's clear that for high efficiencies n must be large.

Two-block construction is favored over four-block since it provides maximum value of n with maximum pole width. Present construction uses pre-skewed slots so a 2:1 speed ratio can be obtained by varying angle θ through a comparatively small range (say 50 to 70 deg). This is possible because with the speed law $v = v_s/cos\ \theta$ there is little change in speed (13.4%) for any variation of θ from zero to 30 deg.

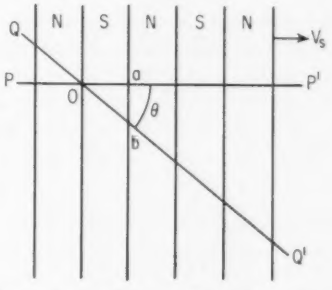
How motor speed is changed



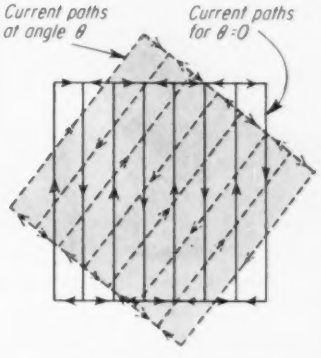
A Stator block is parallel to disk radius



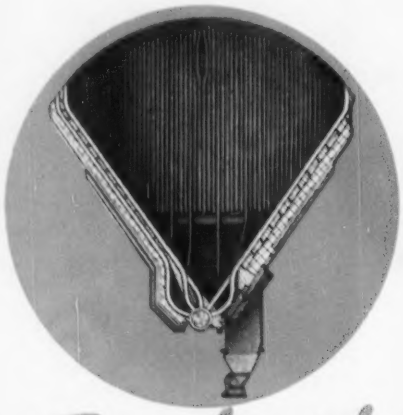
B Stator block is at angle to disk radius



C Conductor QQ' moves at angle to stator



D Current configurations set up in rotor



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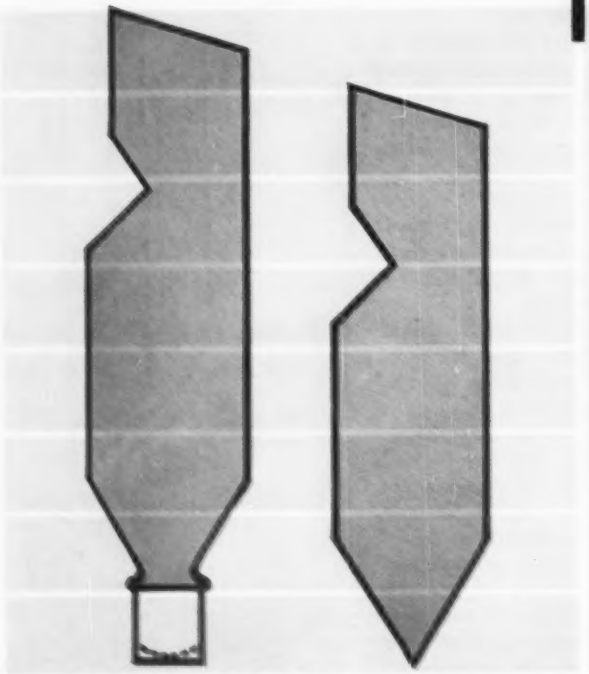
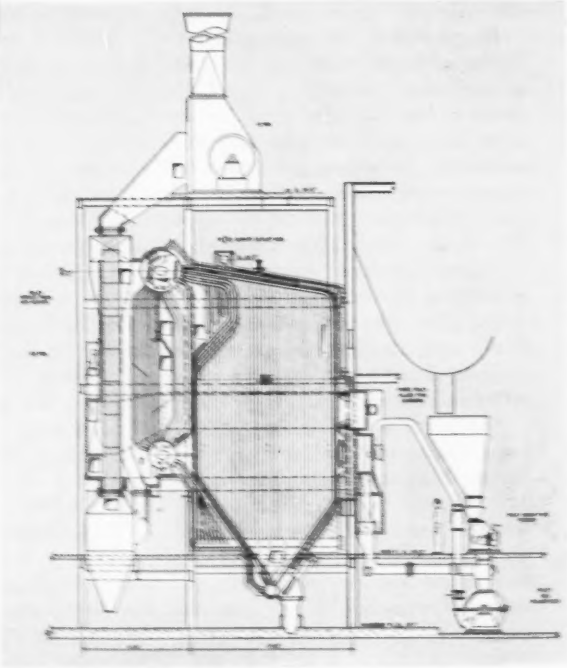


Unit with hopper added. Single Header Hopper Unit.

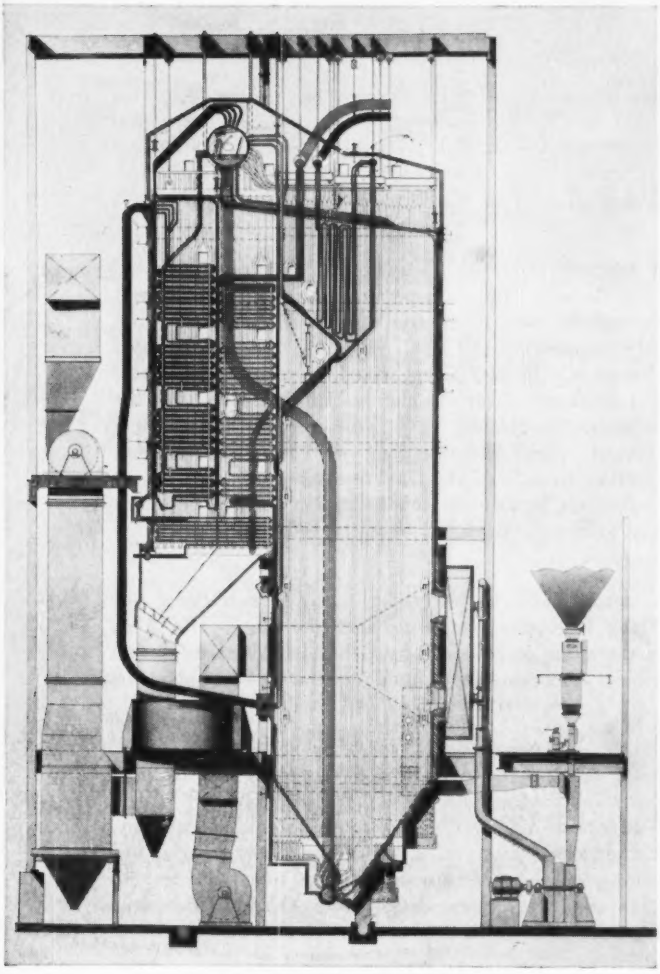


A 60,000 lbs/hr industrial type unit with Single Header Hopper

A survey of your plant by qualified consulting engineers could show ways of making surprising savings in your power costs.

money saving RILEY design feature

Header Hopper Bottom



A large Riley public utility reheat unit with Single Header Hopper

The Riley Single Header Hopper is so called because the furnace wall tubes are used as the sloping sides of the hopper and connect to a single header at the bottom. This simple arrangement eliminates the space required to install a separate ash hopper, thus reducing the overall height of the unit and permitting a unit of higher capacity to be installed where head room is a limiting factor. Additional savings are realized in the elimination of hopper seals and their maintenance.

Riley units with Single Header Hopper Bottoms are especially suited to multiple fuel firing and are extremely successful with coals of low ash fusion temperature. If installed initially to burn either coal or gas, coal can be burned at any time; a simple hydraulic or pneumatic ash removal system can then be added.

Riley Single Header Hopper Bottom Units are furnished in any steam capacity, temperature and pressure.

It will pay you to investigate further the economies possible in this exclusive Riley design feature.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

Riley Stoker Corporation, Worcester, Mass.

Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, Seattle, St. Louis, St. Paul, Syracuse, Worcester.

For more facts circle 241 on Reader Service Card, p 100

Nuclear notes

By B G A SKROTZKI, Associate Editor

Argonne Low Power Reactor (ALPR) operation may be awarded to Combustion Engineering, Inc, Nuclear Division. They are now negotiating with AEC for a contract to run the ALPR at the National Reactor Testing Station, Idaho, as well as to research and develop the plant for greater utility. The CE proposal was chosen from among 13 received by the AEC. ANL designed the plant for AEC to be used in military service. ALPR went critical August 12 and developed full power of 3 mwt on October 24. This natural-circulation boiling-water reactor will produce 200 kwe and 400 kwt for space heating. The plant is housed in a 38-ft-dia 48-ft-high steel tank.

Prices for U-233 and Pu-239 have been set by the AEC to compete with the fuel value of U-235. Base charge for U-233 is $15 per gram; plutonium is $12 per gram. This pricing should encourage the development of these nuclear fuels for power reactors. Users pay an annual lease charge of 4% of the base charge. The President allotted 3.6 kg of U-233 and 37.5 kg of plutonium for domestic use.

Helium-cooled graphite-moderated reactor to develop 30 to 40 mwe has been proposed to AEC by Philadelphia Electric Co and High Temperature Reactor Development Associates, Inc. The associates include over 40 electric utilities in the U.S.A. and Hawaii. This has been the only response to the AEC invitation of last September for proposals for a gas-cooled reactor. Bechtel Corp would be prime contractor; General Atomic Div of General Dynamics Corp would be subcontractor for the nuclear part of plant and Westinghouse Electric Corp subcontractor for turbine-generator and associated equipment. Plant construction will cost $24.5 million. The proposal requests $14.5 million from the AEC for research and development aid. The 90-day negotiation period set by law for this invitation expires February 21, 1959. Plant would be ready to run by late 1962 or early 1963.

Design contract for a boiling-water reactor with nuclear superheating is now being negotiated by the Puerto Rico Water Resources Authority with the AEC. The AEC would pay about $250,000 for the study to be made by General Nuclear Engineering Corp. This study will not be a commitment to build such a reactor plant in Puerto Rico.

Heavy-water-moderated reactor study proposal by Sargent and Lundy of Chicago has been accepted by AEC as a basis for contract negotiation. The study will cover evaluation of feasibility and economics of a variety of heavy-water-moderated reactors using natural or slightly enriched uranium. From this a plant will be designed and construction estimates prepared. Sargent and Lundy won out over 14 other proposals — they intend to engage Nuclear Development Corp of America, White Plains, N. Y. as nuclear design subcontractor.

Atomic get-together called First International Symposium on Nuclear Fuel Elements sponsored by Columbia University and Sylvania-Corning Nuclear Corp will be held on January 28 and 29 at the university in New York City. About 16 talks and two luncheons and a dinner are planned. For registration form apply to Dr H H Hausner, 730 Fifth Ave, New York 19, N. Y.

THIS IS THE TRAP FOR HIGH PRESSURE POWER PLANT JOBS

Pressures *high?* Temperatures really *hot?* Then the Yarway Integral Strainer Trap is the steam trap for the job.

Yarway Integral Strainer Impulse Steam Traps drain some of the hottest steam lines in the country, with temperatures to 1050°F and pressures as high as 2500 psi.

These traps have ample capacity when system is being warmed up, yet handle relatively small amounts of condensate without losing prime. In the presence of dry or superheated steam, the trap valve snaps shut.

Utilities and other high pressure plants also benefit from further advantages like *small size, light weight, steel construction, easy maintenance.* Available in six sizes, flanged or welding ends.

Over 1,250,000 Yarways already sold. For full information, call your local Yarway Representative or write

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.

SERIES 60—normal needs, pressures to 400 psi, 6 sizes. **SERIES 120**—normal needs, pressures to 600 psi, 6 sizes. **SERIES 40**—for extra heavy loads, 5 sizes. **NO. 30**—for extra light loads (½" only). **INTEGRAL STRAINER**—highest pressures and marine use, 6 sizes.

YARWAY impulse® steam traps

For more facts circle 242 on Reader Service Card, p 100

Reserved for your comment

BOB BELLAS, Associate Editor

Let's take it to the U.N.

I have read with great interest the different comments for and against 'boiler hp.' ("Let's kill 'boiler hp,'" August 1958, p 73; "More about 'boiler hp'" and "Kill 'boiler hp'?" November 1958, pp 73 and 93 respectively.)

I won't take sides on this issue, since it is a purely American problem. The 'boiler hp' is absolutely unknown in Europe and, until this discussion started, the exact significance of the term had always been a deep mystery to me.

This seems to dispose of the argument that a boiler couldn't be sold unless its capacity was expressed in hp. We do it quite often.

As to the relative merits of 'Btu per hr' and 'lb per hr' (or 'calories per hr' and 'tons per hr') I feel that it is mostly a point of view; it depends on which aspect of the problem you lay emphasis on. For most heating and process uses, the designer is concerned with the amount of heat units per hr to supply at a certain place. So, it seems that it would be logical to express boiler capacity in terms of heat units per hr.

In the power production field, big problem for the designing and operating engineers is the large amounts of fluids to be handled, such as water. These amounts, expressed in weight units, are the basis for the piping and pumping layout. Hence the notion that boiler capacity should be expressed in terms of weight units per hr.

I don't think this will teach anyone anything. Please accept it as a modest contribution to your ever so interesting magazine.

P VANHERK
Union des Centrales Electriques
Liege, Belgium

. . .'Boiler hp,' 'lb per hr,' 'Btu per hr,' 'heating surface,' etc, like miles, inches, lightwaves, etc, depend on the user.

Boiler horsepower was the most useful term for plant owners in the early days of steam power. It was a *quality* term, meaning it would run an engine of the same hp under any and all conditions of fuel, draft, water temperature, boiler cleanliness, weather, green fireman, or any other possible condition which might arise, with no if's, and's or but's. It has no particular usefulness now.

Lb per hr became useful terminology with the advent of steam metering and competitive efficiency tests. Abortive use of the term as a means of sizing boilers (by some unscrupulous boiler salesmen) has detroyed its value as a *quality* measure.

Btu per hr is a very useful term and has definite value, particularly under test conditions. It's well liked by persons using large, well-rounded numbers —billions, trillions, etc. But Btu is a term which cannot be misinterpreted by anyone. It should be the accepted unit.

W A SHATTUCK, *Chief Power Engineer*
American Sugar Refining Co, Boston, Mass.

. . . I do not intend to deal with the questions of 'boiler hp' or 'lb per hr.' However, I think I may make a suggestion: When the housewife does her shopping she does not buy 1000 g, she buys 1 kg. I think it would be advisable to adopt a new term, 'klb,' to be used when designating quantities relating to boilers, pumps, etc and eliminate three zeros. 1000 klb hr is shorter and easier to read than 1,000,000 lb per hr. To be sure, klb is not an officially accepted standard unit. But why shouldn't the engineer create his own tool in the use of language too, and thereby prepare the introduction of a new unit of measurement?

GERHARD WELLER
Werner-Von-Siemens-Strasse
Erlangen, Germany

EDITOR'S NOTE: *Reader Weller has a point, though it isn't entirely new. There is a trend toward a change in quantity designations, such as 'm' lb per hr steam to represent capacity and 'mbh' to express Btu per hr. Perhaps we'll eventually come up with simplified, standardized terminology.*

Odds and ends

CORRECTION: A note from Lyle Schueler points out a typographical error in his article. (Steam or air: Which costs more for boiler cleaning?," November 1958, p 96.) The second footnote under Table II—Steam costs, p 96, should read "Estimate $80.00 per year per blower unit" instead of $30.00.

The difference is of some significance and we're guilty of missing this printer's miscue, so blame us rather than sudden inflation for the increase.

To those believers in stitch-in-time philosophy, we pass along some info we got from Bert Anthony, who is executive vice-president of the Industrial Security Institute.

The Institute's third annual conference is now in the planning stage. It'll be on deck around the first of May 1959 in Baton Rouge, La., with that city's Industrial Mutual Aid organization hosting the affair. (See "Include your neighbors in your disaster plans," POWER, August 1958, p 116.)

Response to the first and second conferences (Charleston, W. Va., and Elizabeth, N. J.) was an indication of industry's desire to have such a setup. It's especially notable in view of the general public's apathy toward civil-defense activity. continued

Powermaster® . . . FIRST WITH STEAM ATOMIZATION FOR LOW-COST NO. 6 OIL

Here's vital, dollars-and-cents news for the medium-sized user of process steam. Orr & Sembower has developed a new steam atomizing burner for POWERMASTER packaged automatic boilers that breaks down the heaviest #6 oils into clean-burning fog. You can save up to 2c or more per gallon by burning #6 oil instead of #5 oil . . . cut fuel bills $16,000 on an annual consumption of 800,000 gallons. The O&S steam atomizing burner is tailored for industries such as dairies, food and chemical processors, textile and metalworking plants. Available in complete POWERMASTER packaged boiler units from 40 hp to 600 hp and as a separate burner system. No comparable atomizing system for packaged fire tube boilers has been available before from any manufacturer. The new O&S burner gives freedom from operating difficulties to a degree never before experienced except in large, expensive field-erected boilers. The rugged burner has no moving parts to clog or wear, and steam scrubbing action keeps the nozzle clean. Cost? A steam atomizing POWERMASTER can pay for itself in less than two years. Know of any better plant investment? Frankly, we don't. Suggestion: Write, wire or phone us today for the complete story.

ORR & SEMBOWER, INC.
850 MORGANTOWN ROAD
READING, PA. • Since 1885

Powermaster PACKAGED AUTOMATIC BOILERS

For more facts circle 243 on Reader Service Card, p 100

More **comment**

Hats off to you, MoS_2

Your article concerning the effectiveness of molybdenum disulfide as an extreme pressure lubricant was excellent. ("Solid lubricants," November 1958—a *Today's Development* report).

Back in 1954 a manufacturer's service engineer introduced me to MoS_2. Since then I've used this lubricant in various forms on nearly every type of power-plant equipment with excellent results.

I thought your readers might be interested in some applications in connection with equipment which commonly present power-plant engineers with lubrication problems:

(1) Retractable soot blowers using superheated steam. Here we used powdered MoS_2 mixed with a high-grade mineral oil (140 ssu). Brushed on blower tubes once a week, it provided lubrication for both tubes and glands. Packing gland maintenance was cut 50%. (2) Multiport gage-glass studs. We used MoS_2 to minimize thread friction and prevent galling. In this instance torque as specified by the manufacturer had to be reduced due to lessening of thread friction. However, we kept uniform gasket compression and there was no evidence of galling. (3) Steam turbines. MoS_2 was used to lubricate all cylinder cover and steam-pipe flange studs during general turbine overhaul to insure free running nuts and prevent thread galling. At a dismantled inspection two years later, studs showed no signs of galling. This is in contrast with a previous dismantled inspection which involved replacement of two studs at a cost of about $300. (4) Hot air-duct damper bearing. MoS_2, mixed with a high-grade mineral-base grease applied to the bearings once a week ended a vexing problem. Previously we had to shut down a furnace once a week to clean, and sometimes replace, these bearings. (5) Coal conveyor. During low-temperature weather and heavy load conditions, sleeve bearings on this equipment would bind. MoS_2, again mixed with a light grease, put an end to this.

While my experience with molybdenum disulfide has been very gratifying, a word of caution is in order. MoS_2 particle size and purity is extremely important. I'd recommend that before using it the plant engineer should thoroughly consider the equipment manufacturers' lube recommendations.

D M FRANKIE, *Grand Rapids, Minn.*

Decorated and shot

Congratulations to you and Mr Harding for an interesting and vivid article. ('What would *you* have done,' November 1958, p 121). I can appreciate his situation because I served on small ships such as patrol craft and sweeps. However, I wish there had been more information on what happened to the boiler. Maybe shock starting a seam, or tube ends? Or maybe a fusible plug let go.

Even so, leakage couldn't have been too severe or he couldn't have kept on firing the boiler. An emergency feed bottom (*reserve feed tank to you landlubbers*—ED.) should have been ready to cut in, plus taking any other fresh water available on board. Surely, water rationing isn't new in any navy. Assuming he *couldn't* have done anything about getting fresh water feed, when the run on the sub was over the boiler should have been put on continuous blowdown and compound poured into the hotwell. This was an accepted and successful procedure when battle damage necessitated using sea water as boiler feed. It would have gotten him into Port Simonstown without the combustion chamber looking like a "salt mine."

JOHN KING, *Brighton, Mass.*

. . . Harding did the only thing possible and is to be congratulated on his action.

G F COLCHESTER, *Comdr, R. N. (Ret) Glasgow, Scotland*

Caveat emptor

Three cheers for C T Baker. His letter is a bull's-eye on a subject badly in need of some publicity. ('Watch the lowest bidder,' Nov 1958, p 122.)

This sort of thing goes on much too often. Many people in charge of operations involving purchasing don't seem to know enough about their jobs to warrant their right to hold them. Too many purchasing agents are nothing but champion office politicians who can get things for their office friends —and no one else; and from their own pet sources —and no one else. Too many are convinced that they are eminently qualified to pass on matters such as indicated by Mr Baker. Invariably results are similar to those he describes.

Another fruitful source of trouble for a power plant is the individual who writes specs slanted to favor some low bidder. Usually a vital item is omitted. Invariably, the low bidder is requested to supply it—though no mention of it was made in his bid—and result is a frayed relationship. Example: A diesel generator is ordered as a bare bones job, then it develops that the bidder is expected to include the full switchboard.

It's obvious that purchasing departments sometimes exceed their function and would have no defense if the boss took a hard look at where and how his money was being spent.

G ROSEKILLY, *San Mateo, Calif.*

(Advertisement)

Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

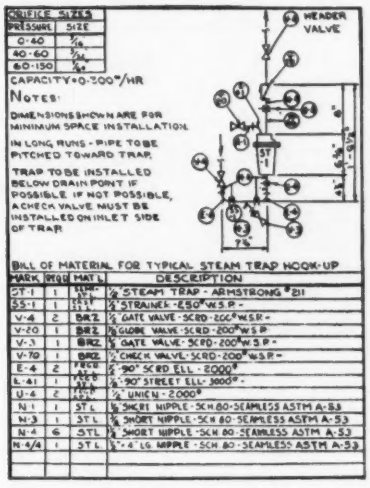

ORIFICE SIZES
PRESSURE | SIZE
0-40 | 7/16
40-60 | 7/32
60-150 | 3/16
CAPACITY 0-300#/HR
NOTES:
DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.
TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.
HEADER VALVE
ST-1
BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP
MARK | QTY | MAT'L | DESCRIPTION
ST-1 | 1 | | ½" STEAM TRAP - ARMSTRONG #211
SS-1 | 1 | | ½" STRAINER - 150# W.S.P. -
V-4 | 2 | BRZ | ½" GATE VALVE - SCRD - 200# W.S.P. -
V-20 | 1 | BRZ | ½" GLOBE VALVE - SCRD - 200# W.S.P.
V-3 | 1 | BRZ | ½" GATE VALVE - SCRD - 200# W.S.P. -
V-70 | 1 | BRZ | ½" CHECK VALVE - SCRD - 200# W.S.P. -
E-4 | 2 | | ½" - 90° SCRD ELL - 2000#
L-41 | 1 | | ½" - 90° STREET ELL - 3000# -
U-4 | 2 | | ½" UNION - 2000#
N-1 | 1 | STL | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3 | 1 | STL | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4 | 6 | STL | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4/4 | 1 | STL | ½" - 4" LG NIPPLE - SCH 80 - SEAMLESS ASTM A-53

Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.
2. Strainer ahead of trap protects it against dirt and scale.
3. Blowdown valve in strainer provides easy cleaning.
4. Check valve in discharge line isolates trap when test valve is opened.
5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8124 Maple St., Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS

Power's data sheet

No. 317

Melting points of reactor materials

Material	F	Material	F
Niobium carbide, NbC	6800	Spinel, $MgAl_2O_4$	3874
Graphite, C	6700	Titanium dioxide, TiO_2	3866
Zirconium carbide, ZrC	6400	Calcium silicate, $2CaO \cdot SiO_2$	3866
Titanium nitride, TiN	5800	Titanium silicide, Ti_5Si_3	3848
Barium phosphide, Ba_3P_2	5790	Beryllium carbide, Be_2C	3812
Titanium carbide, TiC	5700	Calcium chromate, A $CaO \cdot Cr_2O_3$	3812
Zirconium nitride, ZrN	5400	Aluminum oxide, Al_2O_3	3722
Vanadium carbide, VC	5090	Niobium nitride, NbN	3722
Strontium zirconate		Molybdenum disilicide, $MoSi_2$	3686
$SrO \cdot ZrO_2$	5070	Nickel oxide—aluminum oxide,	
Magnesium oxide, MgO	5070	$NiO \cdot Al_2O_3$	3668
Zirconium oxide, ZrO_2	4900	Beryllium silicate, $2BeO \cdot SiO_2$	3630
Molybdenum, Mo	4760	Barium oxide-aluminum oxide,	
Barium zirconate, $BaO \cdot ZrO_2$	4748	$BaO \cdot Al_2O_3$	3630
Cerium oxide, CeO_2	4712	Magnesium sulfide—strontium	
Calcium oxide, CaO	4660	sulfide, MgS, SrS	3600
Molybdenum carbide, Mo_2C	4650	Nickel oxide, NiO	3560
Zircon, $ZrSiO_4$	4622	Niobium disilicide, $NbSi_2$	3542
Beryllium oxide, BeO	4568	Barium oxide, BaO	3490
Cerium sulfide, CeS	4440	Beryllium oxide—aluminum oxide,	
Strontium oxide, SrO	4406	$BeO \cdot Al_2O_3$	3470
Silicon oxide, SiO	4406	Silicon nitride, Si_3N_4	3452
Yttrium oxide, Y_2O_3	4380	Chromium carbide, Cr_3C_2	3440
Niobium, Nb	4380	Chromium, Cr	3430
Vanadium nitride, VN	4280	Zirconium, Zr	3350
Calcium zirconate, $CaO \cdot ZrO_2$	4230	Molybdenum beryllide, $MoBe_2$	3344
Chromium oxide, Cr_2O_3	4127	Mullite, $3Al_2O_3 \cdot SiO_2$	3290
Zirconium silicides, Zr_3Si_2,		Zirconium beryllide, $ZrBe_9$	3180
Zr_4Si_3, Zr_6Si_5	4010-4080	Vanadium, V	3150
Aluminum nitride, AlN	4060	Silicon dioxide, SiO_2	3110
Silicon carbide, SiC	4000	Zirconium disilicide, $ZrSi_2$	3092
Barium sulfide, BaS	4000	Vanadium disilicide, VSi_2	3020-3180
Beryllium nitride, Be_3N_4	4000	Molybdenum aluminide, MoAl	3090
Barium nitride, Ba_3N_2	3990	Titanium, Ti	3074
Chromium aluminide, CrAl	3920	Nickel aluminide, NiAl	3000
Molybdenum aluminide, Mo_3Al	3900	Zirconium aluminide, $ZrAl_2$	3000

—Nuclear Development Corp of America, White Plains, N. Y.

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News and Notes on...

Good Packing Practice

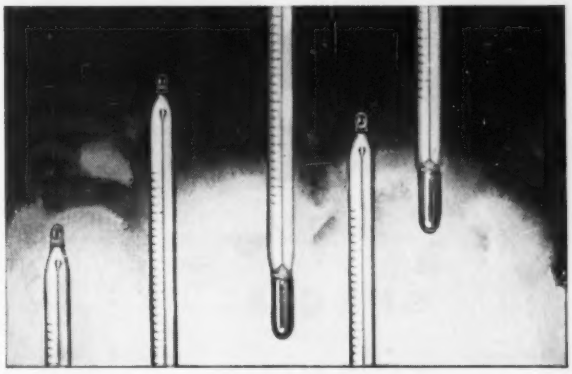
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: High Operating Temperatures

Question:

What sealing materials are currently available that will match conditions brought about by higher and higher operating temperatures?



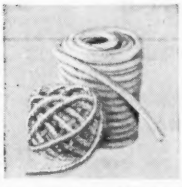
Condition 1

FOR LASTING VALVE SEALS AGAINST SUPERHEATED STEAM AND DRY GASES

Designed to meet today's demand for a packing that will maintain a tight seal against steam and dry gases on valves working at line temperatures up to 1200F, J-M High-Temperature Valve Stem Packing, Style 397, offers the three-way protection of a heat-resistant plastic core, asbestos yarn, and Inconel wire reinforcement. For lasting protection of valve stems during storage, this efficient packing is now available with J-M No. 9 corrosion inhibitor.

Condition 2

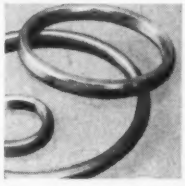
FOR UTILITY SEALING IN GENERAL APPLICATIONS REQUIRING HEAT AND FLAME RESISTANCE



Wherever your operation calls for a utility gasketing material that withstands both heat and flame, specify J-M Asbestos Rope, Style 4200. Made of 99% pure asbestos, this material can take temperatures far in excess of other grades of rope. You'll find it a handy, reliable gasket for sealing joints between furnace doors and brickwork, boiler expansion joints, blast furnace connections, ingot moulds, and countless other uses. Ask for information about J-M Style 4200 Asbestos Rope.

Condition 3

FOR FLANGES WORKING AT TEMPERATURES TO 1600F AND HIGHER



Elevated temperatures are efficiently sealed using J-M Goetze V-Tite Gaskets. Used in flanges grooved for ring joint gaskets. Materials are available for service ranging upwards of 1600F. Controlled hardening assures correct flow of material at low bolt stress. Temperature range −320F to +1600F and higher.

Condition 4

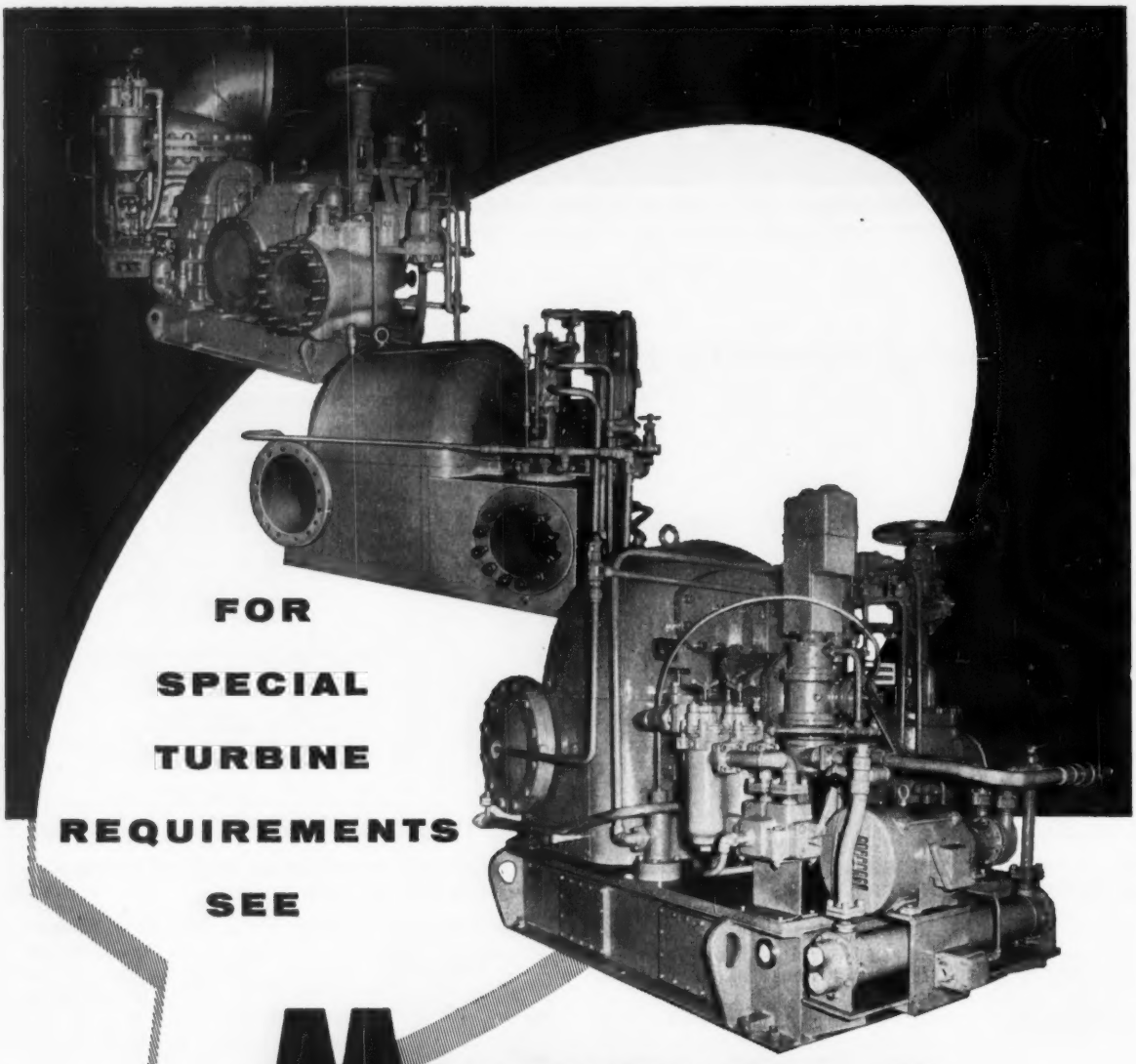
FOR PACKING PROBLEMS IN ANY TEMPERATURE RANGE

Your Johns-Manville field representative is a trained specialist in packing problems of all types. He's located near you, to help out whenever you need specialized packing information. For information on new packings and gaskets—for engineering and design advice—for tips on more efficient, more economical packing techniques—your Johns-Manville representative is a good man to know.

For information on any Johns-Manville Packings and Gaskets, write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE

For more facts circle 245 on Reader Service Card, p 100



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Murray TURBINES

- Low Inlet Pressures
- High Back Pressures
- High Speeds
- Variable Speed Ranges
- Precise Control
- Multi-Valve Designs
- Double End Gear Drives
- Vertical Shaft Turbines

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Technical briefs

Latest engineering developments for busy power men

11 papers for you on:
BOILER DESIGN
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FEEDWATER PUMPS

Tomorrow's boilers have same problems as today's: heat, corrosion, auxiliaries

EDITOR'S NOTE: *The ASME-AIEE Power Conference in Boston covered several phases of power generation. Papers are reviewed here either by group or individually.*

Modern steam-generator designs *by D R Wilson, Babcock and Wilcox Co* (ASME paper 58-PWR-16) and **Trends in present-day boiler design** *by D B Stewart, Foster Wheeler Corp* (ASME paper 58-PWR-17). Both papers discuss current utility-sized steam generators. Both bring out the following points: (1) The concept of boiler-turbine units exists because of increased boiler availability. Integral tube design has been a major step in this direction. (2) Pressurized furnaces are usually best because of large power savings and lower investment in fans, auxiliary equipment and structural steel. (3) Once-through boilers, in both sub- and super-critical design, are gaining in use.

(4) Multiple reheat has proved out, but (5) temperatures will stagnate until present-day metallurgy advances. (6) Silica is still a major problem, although two different methods of control are presented. *Trends* explains in detail the use of dual circulation—primary and secondary loop. One system uses two primaries and one secondary. Silica carryover to turbine is 0.005 ppm, although concentrations in boiler circuits are much higher. *Modern designs* discusses the cyclone-separation process, which separates, washes, and separates again before passing steam on to the turbine.

Trends also lists disadvantages of the once-through units and important design criteria for both natural-circulation and once-through types. One possible way of licking the gas-corrosion problem is spray-injecting ammonia into the gas stream to prevent formation of sulfuric acid.

Modern designs details the designs of different high-capacity boilers prevalent today, the application of multifuel burners, and cyclone furnaces. Pressurized furnaces are OK for gas and oil, but sealing problems make the use of pulverized coal questionable at this time.

A preview of tomorrow's boilers *by E M Powell and J I Argersinger, Combustion Engineering,* looks at boilers coming up in the near future — next two years. The single-system concept will be maintained, as indicated by a 500-mw generator with a 3.5-million lb per hr connected boiler ordered for delivery in 1960.

Supercritical requirements will be best met with the once-through boiler. Although feedwater temperatures have been boosted to 575 F they may come back to 560 F as a more economical point—further study is needed in this area. Main steam of 1050 F with double reheat to 1050 seems to be the economical limit.

Controls are another key to successful operation of tomorrow's boilers. Control by feedwater injection into the superheater followed by a small finishing superheater is used in Europe. *ASME paper 58-PWR-14*

Design requirements for steam generators with high-cost fuels *by C F Hawley, Riley Stoker Corp.* This paper describes design features of special importance for plants where fuel costs are a problem. New England is used as the geographical area.

Multifuel design, even gas distribution through the furnace (governed by furnace and superheater design), and water-cooled platens across the upper furnace will all help get the most value from fuel used. Platens keep superheater between 1035 F and 1050 F and cut possibility of slagging.

Low air-heater exit temperature is needed, but corrosion is still a problem. Air recirculation is one possibility, with more of it used with the higher-sulfur-content fuels. Low-level economizers, using cast-iron pipes, can be placed in the gas stream after the air heater, and used to preheat the air before it gets to the heater. This raises the average metal temperature of the cold-end heater elements and reduces the corrosion rate.

Pressurized furnaces and steam-driven auxiliaries add to the saving. And data logging is a step toward the most efficient automatic plant. *ASME paper 58-PWR-15.*

Industrial power is different *by R K Patterson, Charles T Main, Inc.* Of the 300,000 manufacturing plants in the U.S., only 1/3 generate all or any of their own power. Yet the 1/3 take ¾ of all the heat power and electric power used in manufacturing. Their plant investment makes up 2/3 of the total for all manufacturing plants, they spend twice as much for heat as electrical energy, and they are both the largest purchasers and generators of electricity. They are the basic-material producers, manufacturers of primary metals, petroleum, coal and paper products, chemical, lumber and food products.

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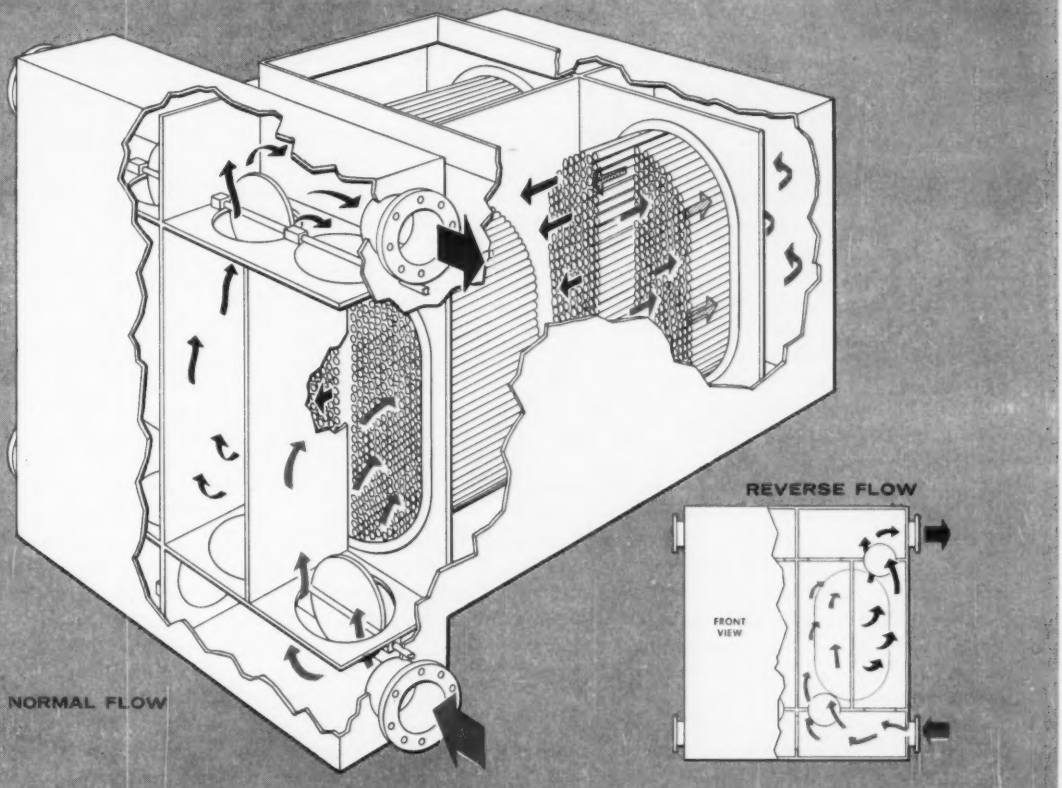

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The most important item in energy purchasing vs self generating is the ratio of fixed assets to total assets. The basic-material producers have a ratio runing from 40 to 60%, while the others have less than a 35% ratio. The first group has long payback periods, while the second group's periods are short.

Other points that are important are inventory cost, current-asset requirements, payback period on plant investment, geographical location and type of power available, government or private.

Industry has a problem in payback periods not found in utilities. Manufacturers mostly use depreciation financing, and pay out nearly 40% of the annual value added by plant as income tax. Utilities, on the other hand, do about half their financing by long-term debt, and pay out in income tax only about 20% of the annual value added by the plant.

Comparison of industrial and utility payback periods indicates a 2-year-payback company would be ten times more interested in investment costs than a utility. It would be nearly eight times more interested in cutting investments than in upping efficiencies. A plant with 4000-hr payback (twice the yearly hourly use) would find it best to throw away as much as 8% in efficiency to get a 1% cut in investment costs.

In the industrial-power picture there are five key persons; the mill manager, the division superintendent, the power superintendent, the consulting engineer and the manufacturer.

(1) The mill manager applies four tests to any suggested improvement in his power system: (a) will improvement retire investment in about four years (b) will operating savings equal a competitive advantage (c) is investment needed for continued product-output rate desired (d) is the money available—he'll generally borrow only for equipment of extreme importance.

(2) The division superintendent of manufacturing is interested in whether he can make enough of the product and make it good enough. He only cares whether steam and power is "there when he needs it and as much as he needs." How it gets there is of minor importance to this man.

(3) The power superintendent thinks like a utility chief engineer, but should accept management's attitude and change his sights. He would gain more by examining how the plant uses steam in order to save there rather than at the boilers. But all his time is taken up by paper work requested by the process divisions and daily work required by the power plant itself. Since most plants will spend about three dollars out of every hundred for steam and power, a saving in efficiency there doesn't mean much, but a saving in steam use could quickly add up to dollars saved on the superintendent's budget.

(4) The consulting engineer must realize management's viewpoint. To the manager, speeding a construction job, even at a premium, may be more important than economical construction. Concentrating on getting more use from existing equipment, upping production, evening up loads is more important than most of the savings he can make in the power plant.

(5) The equipment manufacturer, to get the sale, must make plant equipment simple and rugged, with lots of capacity, high reliability, easy maintenance. He needn't worry about producing extremely high efficiency. *ASME paper 58-PWR-5*

The integration of single turbine-driven feed pumps in large generating units *by J A Tillinghast and J E Dolan, American Electric Power Service Corp.* This paper proposes using a separate steam-driven turbine to drive a full-capacity feedwater pump servicing a large generating turbine-boiler. Studies made after 1954 of half-sized motor-driven feedwater pumps and full-sized steam-driven units using a separate turbine indicated that the latter were better. Savings were found in the pumps themselves (a full-sized high-speed unit costs only 25% more than a half-sized 3550-rpm style), feedwater heaters, main turbine-generator, piping, valves, electrical auxiliaries and installation costs, and increased steam-cycle performance.

Pump turbine usually takes steam from the cold reheat and extracts lower-temperature nonreheated steam to the feedwater heaters. It can also take steam from the boiler and exhaust either to the main condenser or atmosphere. This is with 225-mw units, installation of which started in 1957. Savings varied from plant to plant, but ranged between $1 and $1.50 per kw.

Operation so far has not been without troubles, but all have been minor. The generator-turbines have had trip-outs, but none caused by the pump turbine. Work is now in progress using the same idea for 450-mw supercritical units planned for installation in 1959 and '60. Best location in steam cycle will draw steam from the last six stages of the second-reheat turbine exhaust. Pump turbines on the new units will be rated at 20,000 hp with full flow at 3550 rpm and will release 15,000-kw additional net plant output.

Supercritical design requires a minimum circulation prior to starting the main turbine so a motor-driven half-sized pump is provided for this service. *ASME paper 58-PWR-11*

Evolution of the boiler-feed pump *by R A Baker, Public Service Electric and Gas Co.* Author takes a different look at the same feed-pump problems. Public Service also studied the situation and decided that using two half-sized units driven by the

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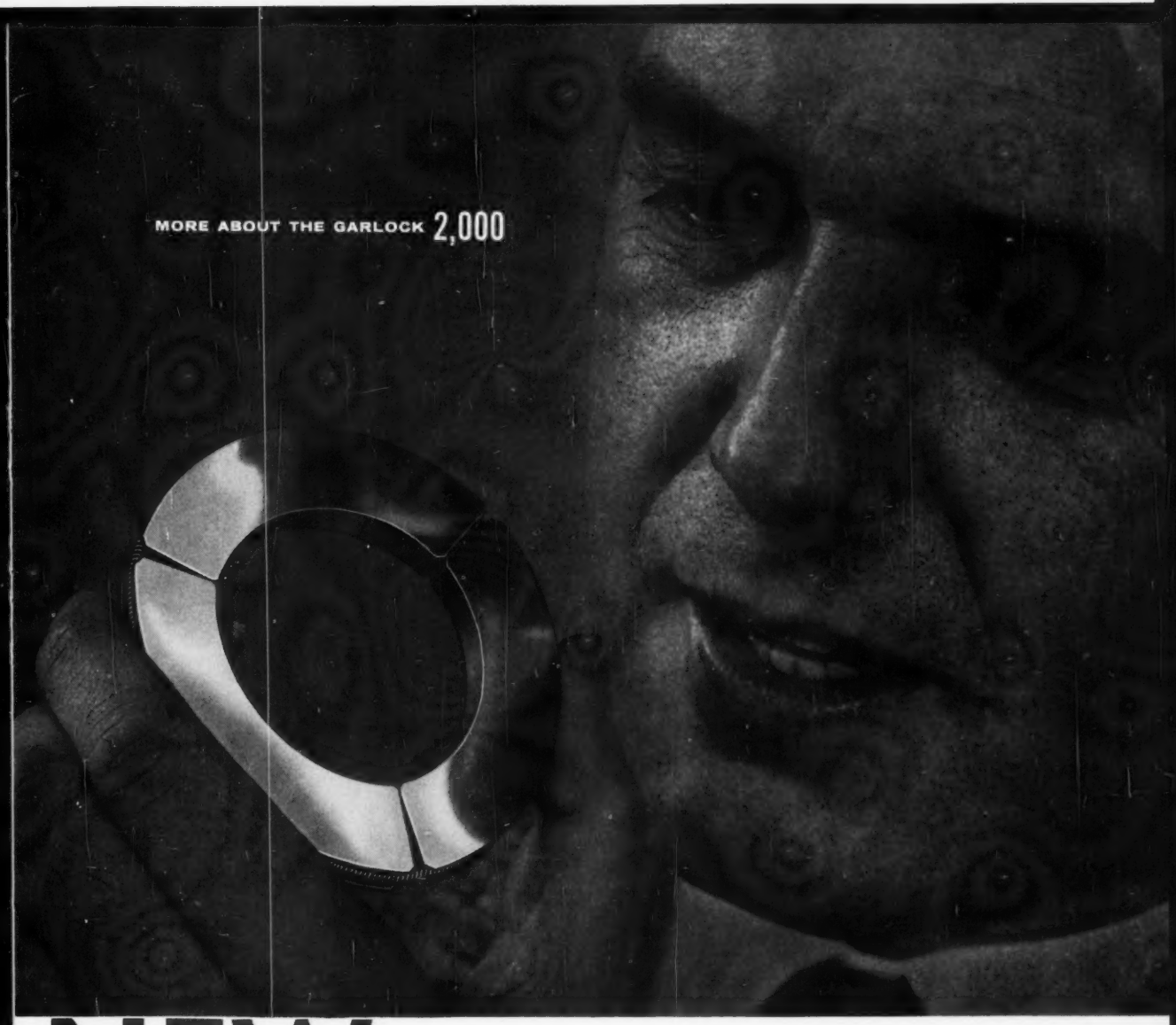

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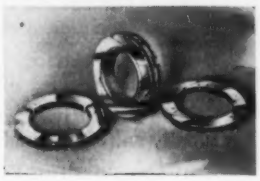

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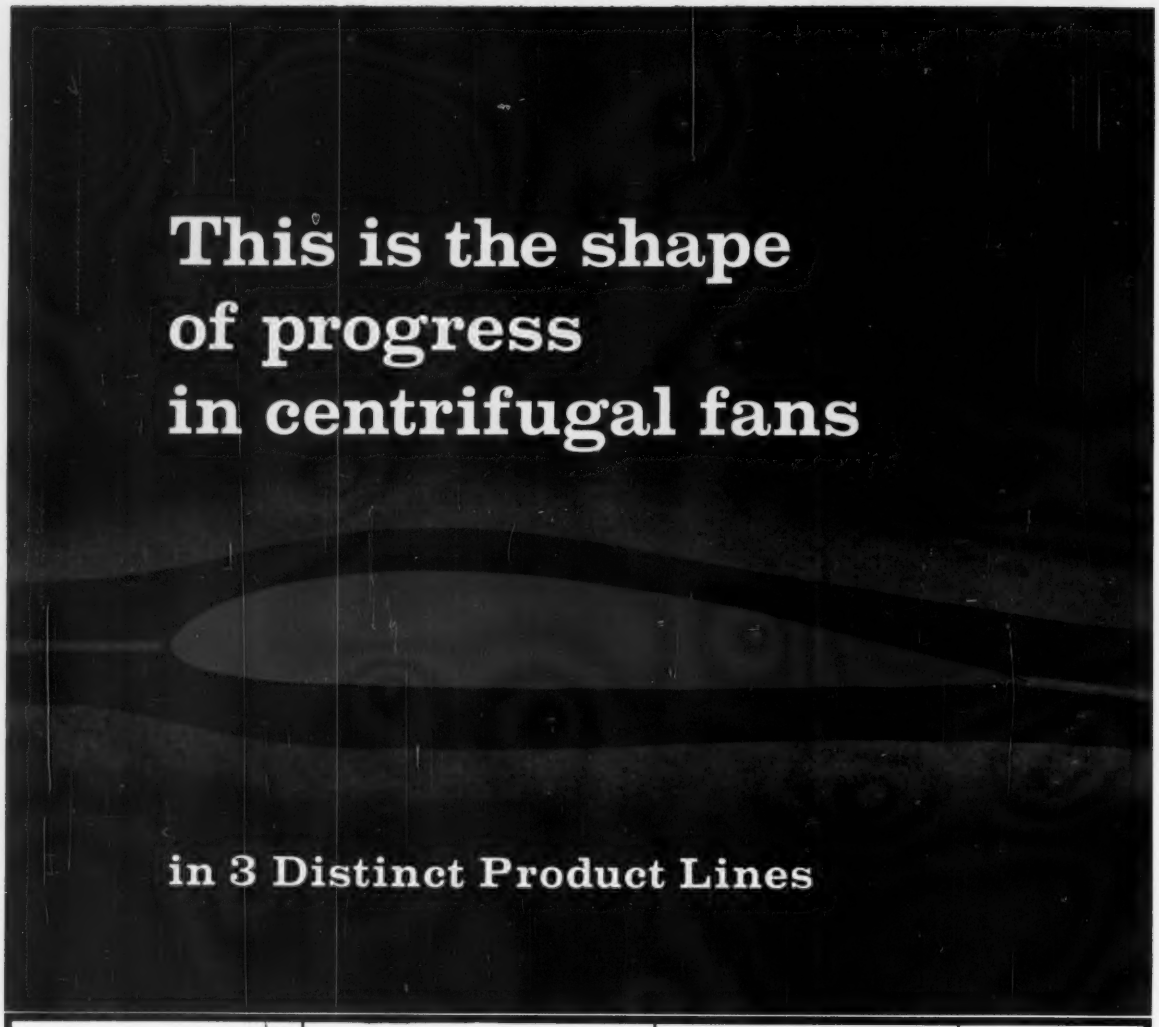

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More **technical briefs**

Begins on page 92

two main turbines of a 290-mw cross-compound turbine-generator would be the best solution. Their saving in motors was $500,000 for four 4500-hp units, including switchgear and controls, installed. Speed control was cut out on the spare half-sized motor-driven pump, since this unit is expected to run only a short time during its life. There was also a space saving.

Two new 320-mw turbines now under design will have the same feedwater pump drives, but the spares will be quarter sized, and cross connections will provide full pump capacity to either turbine. *ASME paper 58-PWR-18*

Hydro

Application of pumped-storage hydro to midwestern terrain. *By G J Vencill, Union Electric Co*

For more than four years Union Electric Co has been investigating the possibilities of pumped-storage hydroelectric generating capacity. A pumped-storage plant would have decided operating advantages if a location with favorable topography could be found. The plant would provide peaking capacity, and would take off-peak pumping energy from the company's own steam plants and from interconnected companies. Unlike other pumped-storage plants recently built in this country, this one would have no seasonal operation connected with flood control or irrigation.

Several possible sites have been studied, and a field investigation was made of a location on Establishment Creek which seemed to combine many desirable features. It was found, however, that the Establishment Creek project was not economically feasible, primarily because an economical physical installation would be of too great capacity to fit properly into the system for some fifteen or more years.

A number of other sites have been located, but no decision has been made to carry any of them into the field-investigation stage. The company believes now that the ideal site is one in which water could be diverted by a rather short flow line to an adjoining valley lower in elevation than the valley in which the dam is built. This takes advantage of a comparatively low dam to create a higher head. It also limits the quantities of water needed to fill the system initially, and makes the best use of available topography. *APC paper, no number*

Electrical features of the Upper Raquette River power project. *By W C Van Dyke, Niagara Mohawk Power Corp*

Development of the upper section of the Raquette River began in March, 1951, with the start of construction on the Carry Falls Dam. Regulation of the river flow made possible by this dam serves to greatly increase the power production of all downstream generating plants.

Downstream from Carry Falls, five separate generating stations have been constructed. Each uses a sizable portion of the total head available between Carry Falls and the older plant at Highley Falls, in "staircase" fashion. Completion of the five plants made over 100,000 kw of additional peak load capacity available to the Niagara Mohawk System. In a normal year, production from the project should exceed 400,000,000 kwhr.

First of the five new plants to go into service was South Colton in spring, 1954. Five Falls followed in spring, 1955, Rainbow Falls in April, 1956, Blake Falls in spring, 1957, and Stark in the fall of 1957.

Energy produced by the new generating stations is fed into the Niagara Mohawk 115-kv state-wide transmission system at Colton, N. Y., the site of an existing major switching station. *AIEE paper, No. CP 58-876*

The Kelsey hydroelectric development on the Nelson River, Manitoba. *By L M Hovey, Manitoba Hydro-Electric Board*

The Kelsey development is the first on this river and was authorized in December 1956 to supply 102 megawatts to the International Nickel Co of Canada Ltd, for operating the new mine and smelter in the Mystery-Moak Lake area of Manitoba. The mine site is now called Thompson and the power site Kelsey.

The first machine is scheduled for operation in June, 1960. Develop-

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Technical briefs

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ment of the power site rests with the Manitoba Hydro-Electric Board, a provincial organization responsible for generation and transmission of electrical energy in Manitoba.

As Kelsey station is the first to be constructed in the chain, and as it is some 400 miles north of the main generating system of the Board, it will initially operate as an isolated plant supplying the power requirements only of the International Nickel Co. Ultimate plans call for an interconnection of all or part of these future Nelson River generating stations with the southern system by extra-voltage transmission, as and when this becomes economically feasible.

Paper describes the generating station and the load to be supplied. *AIEE paper, No. CP 58-877.*

Atomic power

The scope of pressure-vessel codes and activities toward improved content. *By W E Cooper, General Electric Co*

This paper consists of a summary of the scopes of Codes currently available for pressure-vessel design and a discussion of certain activities directed toward the improved technical content and coverage of such Codes, particularly for application to nuclear-reactor components. *NESC paper, No. 78.*

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American Power Conference, 20th anniversary meeting. Identified by initials APC and available from Director, APC, Illinois Institute of Technology, Chicago 16, Ill.

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103 **Ventura fans** are subject of 4-p bulletin 8914. Tables list 42 l-p fans, 50 h-p units; include data on speed, motor hp, weight and delivery. American-Standard, American Blower Div

104 **Infrared** controlled-area heating is described in 4-p bulletin. Shows how heaters can be used to convert waste space to practical uses. Quartz Products Corporation

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107 **Pumpless mercury-arc** rectifiers are described in 12-p bulletin GEA-6848. Operation, construction features, applications are covered for units ranging from 750 kw, 250 v to 5000 kw, 850 v. General Electric Company

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109 **Anode switchgear,** function and application, is discussed in 6-p bulletin GEA-6841. Units are for use with mercury-arc rectifier equipment. General Electric Co

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110 **Paper-insulated** power cable is topic of 152-p manual 1102. Liberally illustrated with photos, charts and diagrams, book is divided into five sections: basic designs and applications; weights and dimensions; formulas, tables and technical info; installation practices; splice and termination drawings, instructions. The Okonite Company

111 **Cable trays,** support systems for cables, wiring and tubing are illustrated and described in 80-p catalog 858. Diagrams, installation info and loading charts are included. P-W Industries, Inc

112 **Explosionproof** electrical equipment design and construction principles are described in 6-p folder 2710. Panelboards, circuit breakers, switches are among equipment made by firm. Crouse-Hinds Company

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ELECTRICAL APPLICATION

114 **Vertical** hollow-shaft motors are topic of 6-p folder 212. Drawings, diagrams, cutaways are included. The Ideal Electric and Manufacturing Co

115 **Floodlights** are subject of 184-p catalog 320. Book has 14 sections; a table of contents for each. "How to select floodlights," "mercury-vapor floodlights" are entirely new sections. Crouse-Hinds Company

116 **Aluminum** electrical application in the building industry is topic of 32-p brochure. Book includes info from a survey of 400 electrical contractors; goes into economics of choosing aluminum for conduit, cable, busway, enclosures. Illustrations show existing installations. Aluminum Company of America

117 **Motorized gear drives** are described in 4-p bulletin 2350. Cutaway, diagrams, specs are given. The Louis Allis Co

118 **Adjustable speed drives** are discussed in 8-p bulletin GEA-6234B. Gives standard and optional features of 1-hp half-wave, 1- to 4-hp full-wave units. General Electric Company

119 **Reduced-voltage starters** are covered in 12-p bulletin 14B8192. Includes motor control engineered for centrifugal compressors, pumps, large fans, m-g sets. Allis-Chalmers Manufacturing Co

120 **Industrial lighting** is discussed in case-history booklet showing how 21 production problems were solved with fluorescent lamps. General Electric Company, Large Lamp Dept

121 **Squirrel-cage** induction motors, large high-speed units, are the topic of 8-p bulletin 210. On-the-job photos, cutaways show features. The Ideal Electric and Manufacturing Co

HEAT EXCHANGERS, CONDENSERS

122 **Redesigned** h-p closures for feedwater heaters, other h-p, h-t exchangers are discussed in 4-p bulletin 201.1K1. Drawings show new design boasting only four major parts. American-Standard, Ross Heat Exchanger Div

123 **Cleanable shell** and tube condensers are subject of 16-p catalog 8044. Heavy-duty high-capacity units are designed to simplify mechanical cleaning where water conditions are poor. Dunham-Bush Co

124 **Heat exchangers,** pressure vessels for the process and power industries are listed in 16-p catalog M581. Includes photos, diagrams, charts. Southwestern Engineering Company

125 **Pipeline aftercoolers** are covered in 8-p bulletin 302.6K1. Specs give details on 54 models for pressures to 125 psig for single and 2-stage compression. American Standard, Ross Heat Exchanger Div

126 **Stainless-steel** exchangers for production, pilot-plant applications in the chemical and process industries are described in 4-p bulletin 301.6K1. American-Standard, Ross Heat Exchanger Div

127 **Air-cooled** packaged chillers and remote-condensing-unit assemblies are covered in bulletin 8027A. Dunham-Bush Co

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NEW LITERATURE listed in this issue, starting on p 99

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ADVERTISED PRODUCTS appearing throughout the issue

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NEW FREE LITERATURE continued . . . . . .circle key numbers, page 100, for your copies

INSTRUMENTATION

128 **Automatic controls** for engines and compressors are covered in 14-p bulletin 87. Application photos, diagrams give details. The Cooper-Bessemer Corp

129 **Diesel-engine controls** are listed in 24-p bulletin B45-1. Photos, diagrams, complete specs included. Minneapolis-Honeywell Regulator Company

130 **Industrial control** line is topic of 8-p bulletin 958. Individual products and assembled controllers are pictured. The Euclid Electric & Mfg Co

131 **Continuous-stream** analyzers are subject of 8-p catalog CL-4000. Industrial pH equipment, gas chromatographs, infrared analyzers are included. Beckman/Scientific and Process Instruments Div

132 **Draft** — what, where, how and why—is discussed in 19-p bulletin 58-S201. Draft gages are also listed and described in this informative booklet. The Hays Corporation

133 **Rotameter,** O-ring seal type, is described in 4-p spec sheet SS-111-2. Gives design, capacity, dimension details. Brooks Rotameter Company

134 **Metal-tube rotameters** for measuring flow of hazardous and h-p fluids at temperatures to 400 F are covered in 4-p bulletin 19A. Schutte and Koerting Company

135 **Test equipment**—volt-ohmmeters, refrigeration and air-conditioning testers—is discussed in 8-p catalog 2060. Simpson Electric Company

136 **Flow transducer** for single or bi-directional flow is topic of 4-p brochure. Ramapo Instrument Co

137 **High-speed** tubeless frequency telemetering for high-distance data transmission is covered in 2-p spec sheet S301-1. Minneapolis-Honeywell Regulator Company

138 **Pressure switch** for controlling, signalling or alarm service is discussed in 2-p spec sheet S1011-3. Minneapolis-Honeywell Regulator Company

139 **Ultra-high-speed** image converter camera is covered in 2-p publication. Librascope, Inc

140 **Industrial TV system** with automatic light control is described in 2-p bulletin. Cohu Electronics, Inc, Kin Tel Div

141 **Digital indicator** and printer is detailed in 2-p bulletin. Gilmore Industries

142 **Weighted gage cock,** an aid to safe boiler operation, is discussed in 2-p circular 183. Lunkenheimer Co

143 **Multiple-point** recorder-controller assembly for 2-position control is covered in 2-p spec sheet ND46-33(6). Unit can be used for overheat protection in nuclear reactors. Leeds & Northrup Company

MATERIALS

144 **Wall chart** listing A1S1 grades of cold-finished steel has 5 pp. Gives complete speeds, a table of weights. La Salle Steel Co

145 **Insulating** and refractory material, Foamsil, is described in 4-p folder FS-1. Outlines physical characteristics, possible uses. Pittsburgh Corning Corporation

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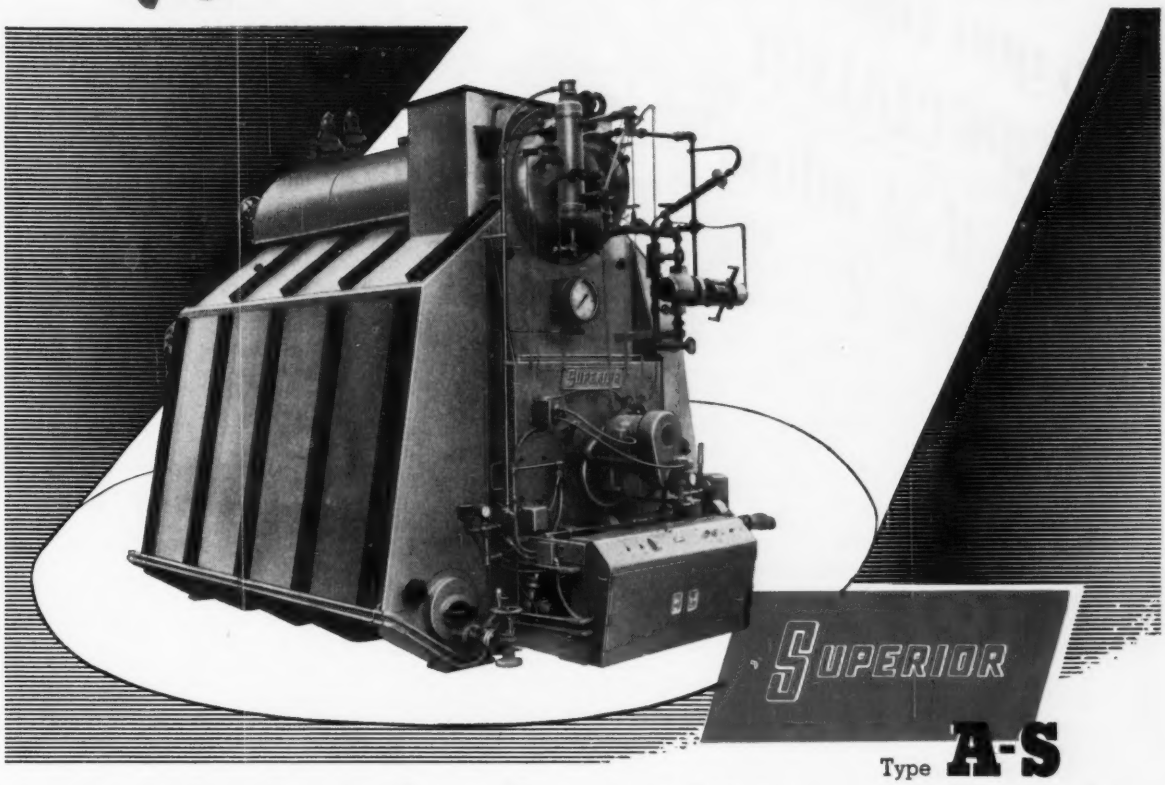

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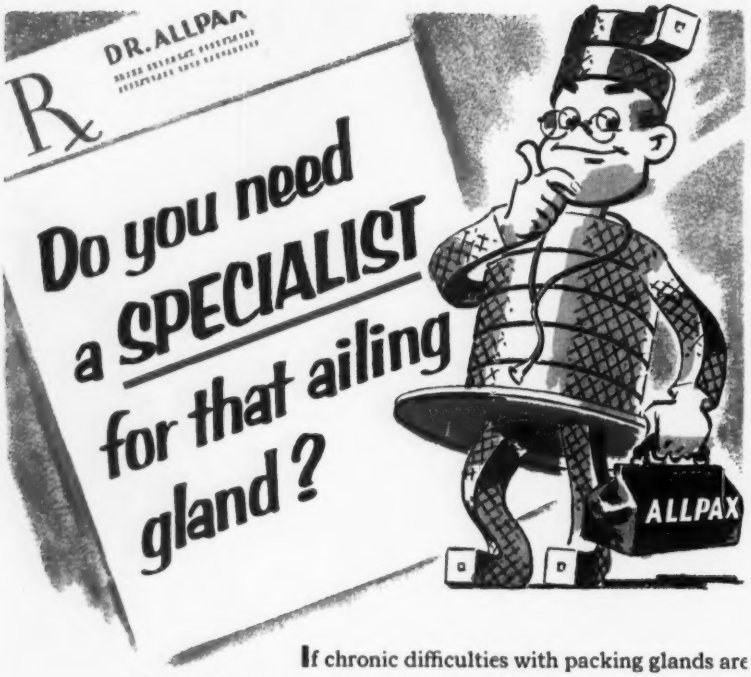
For more facts circle 253 on Reader Service Card, p 100



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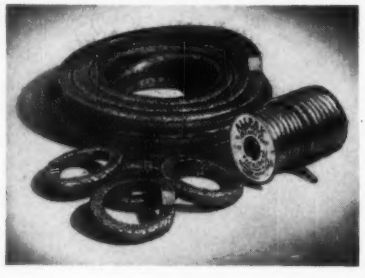

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Free literature

Begins on page 99

146 **"Lead and its Alloys"** is title of 8-p technical reprint. Lead Industries Association

LUBRICATION

147 **Complete line** of industrial products—specialty lubes, greases, heat-transfer oils, refrigeration oils—is covered in 16-p folder. Sun Oil Company

148 **Effect of lubes** on wear-in damage to new machinery is discussed in 8-p newsletter 5. An engineering study of surface geometry of mating surfaces is included. The Alpha - Molykote Corp

MAINTENANCE

149 **Compression packing** recommendations are listed in handy wall chart. Packings for eight basic types of service are included. E F Houghton & Co

150 **Automatic tube-expander** drives are covered in 6-p bulletin 581. Includes an easy-reference chart. Thomas C Wilson, Inc

151 **Maintenance** procedure for predicting failures in motors, other electrical equipment is described in 2-p bulletin 2-60. Shows how to forecast from periodic insulation-resistance tests. Associated Research, Incorporated

152 **Membrane-filter** use in dust and aerosol analysis is discussed in 6-p technical booklet. Equipment is used to make total dust count, determine particle-size distribution. Gelman Instrument Co

153 **Tank-capacity calculator** comes in slide-rule form. Can be used to find capacity of tanks up to 100 ft high, 300 ft dia. Hammond Iron Works

MECHANICAL POWER TRANSMISSION

154 **Sliding motor base** of welded steel is one subject of 12-p catalog V-183-B. Complete specs are given for other variable-pitch drives. Browning Mfg Company

155 **Custom-gear** manufacturer describes plant facilities, products in 12-p bulletin 26 1G. Profuse pix show how the plant works. Illinois Gear & Machine Co

156 **Fan-cooled worm gear** that mounts at any angle is topic of 4-p bulletin 5018. Includes hp, torque data for units built on 2½- to 4-in. centers. De Laval Steam Turbine Co

157 **Flexible gear coupling** with nylon sleeve is described in 4-p folder. Tabular data covers hp and speed ranges, bore sizes. Sier-Bath Gear & Pump Co, Inc

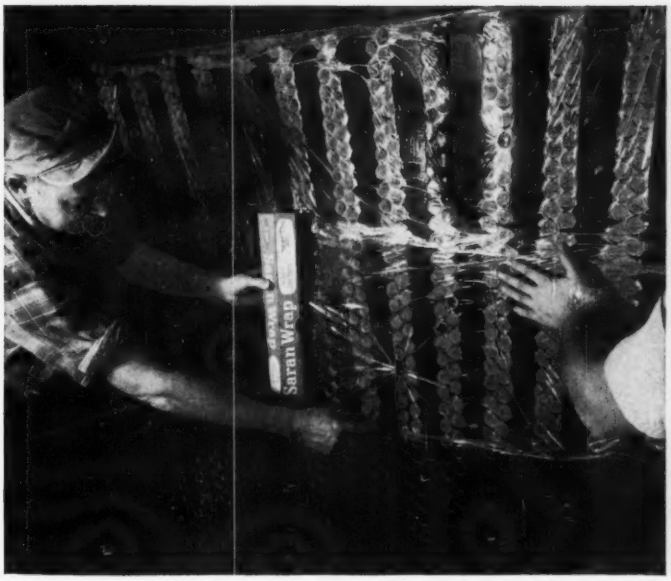
continued

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBE EDITION

Plastic Film Detects Condenser Tube Leaks Without Turbine Shut Down



Maintenance crew spreads plastic film over still-wet tube sheet—a simple, fast operation.

Leaking tube is quickly identified when vacuum inside condenser sucks in plastic film.

A novel and successful method of finding and plugging leaking condenser tubes while the unit is on the line has been developed by operating personnel at the Portsmouth Power Station of Virginia Electric & Power Company, Portsmouth, Virginia. Because this simple method is inexpensive, accurate, and timesaving, it will be of interest to every engineer.

The necessity of a complete shut down to detect a condenser tube leak has now been eliminated and it is possible to take out one half of the condenser successfully, find the leak and return to full capacity 60% sooner than ever before. The key is a plastic film leak detector.

When a tube leak becomes apparent, the condenser is "shot" with sawdust until the leak becomes too difficult to control. At this point the necessary drop in load is scheduled to remove one half of the condenser. Then the condenser is backwashed before taking it off the line to make the leak reappear.

After the circulating water has drained from the leaking half, three operators go into one end of the condenser and cover the entire tube sheet with plastic film. This is most desirable while the sheets are wet. When one end is completely covered, the process is repeated at the other end of the condenser. As vacuum is built up in the leaking tube, the plastic is pulled into that tube showing immediately which tubes are the "culprits." This method has been used many times, returning the condenser to service with one or more tubes plugged and as yet no leak has gone undetected.

Virginia Electric & Power Company's plastic film "leak-detector" method is an ingenious contribution to condenser and heat exchanger maintenance. It is one of many ideas that Bridgeport Brass has brought to the attention of engineers to insure better, more efficient, more economical operation.

Your Bridgeport Salesman — backed by Bridgeport's Technical Service Staff — is continually in contact with the most recent developments in your field. He is always ready to assist you in problems involving the selection, application and use of condenser and heat exchanger tubes. Call him today.

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Higher efficiency of Buell 'SF' Electric Precipitators is the result of exclusive engineering features. For example, Buell's *Spiralectrodes* emit 50% to 100% more electrons than other types . . . and *maintain* their efficiency. Positive gas flow control through adjustable baffles prevents scouring and eddying. And Buell's Unique Continuous Cycle Rapping practically eliminates "puffing".

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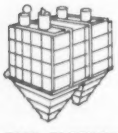
Lower installation cost of Buell's time-proved simplified design makes erection faster and easier. Spiralectrodes, for example, are self-tensioning, require no weights. Flexibility of power supply means easier installation, operating safety.



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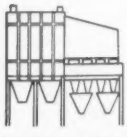

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Begins on page 99

158 **Sheaves,** V-belts, flat-belt pulleys, pillow blocks, many more are included in 8-p bulletin 3010. Specs, photos give details. T B Wood's Sons Company

159 **Longer life** from V-belt drives is topic of 12-p manual. Case histories, trouble-shooting guides select the proper belts to suit your needs. B F Goodrich Industrial Products Company

PUMPS

160 **Screw pumps** are discussed in 6-p bulletin S1-6. Construction, operating characteristics, dimensions and capacities are detailed for pumps from 1 to 2000 gpm. Sier-Bath Gear & Pump Co

161 **Power-driven pumps** are covered in 24-p bulletin 20. Complete line of pumps, 10- to 1580-gpm capacities, is shown. Includes 19 tables and a handy 6-step selection procedure. Blackmer Pump Company

162 **Single-stage** side-suction centrifugal pumps are covered in 8-p bulletin 720.4. Specs, sectional view, dimensional chart, performance curves included. Goulds Pumps, Inc

163 **Ball-bearing** horizontal-split-case double-suction centrifugal pumps for general water service are detailed in 6-p bulletin 251. Includes specs, sectional view, dimensions. Warren Pumps, Inc

164 **Rotary pumps** for bulk handling are topic of bulletin 100. Includes tables, selection info, cutaway photos showing interior compartments. Blackmer Pump Company

STEAM GENERATION

165 **Industrial burners** with built-in fuel and air systems are subject of 4-p folder 5807. Cutaways, diagrams show packaged units for gas, oil or dual fuel, natural or induced draft. Iron Fireman Manufacturing Company

166 **Automatic fuel burner** is topic of 8-p brochure 430B. Has installation photos, features. Peabody Engineering Corporation

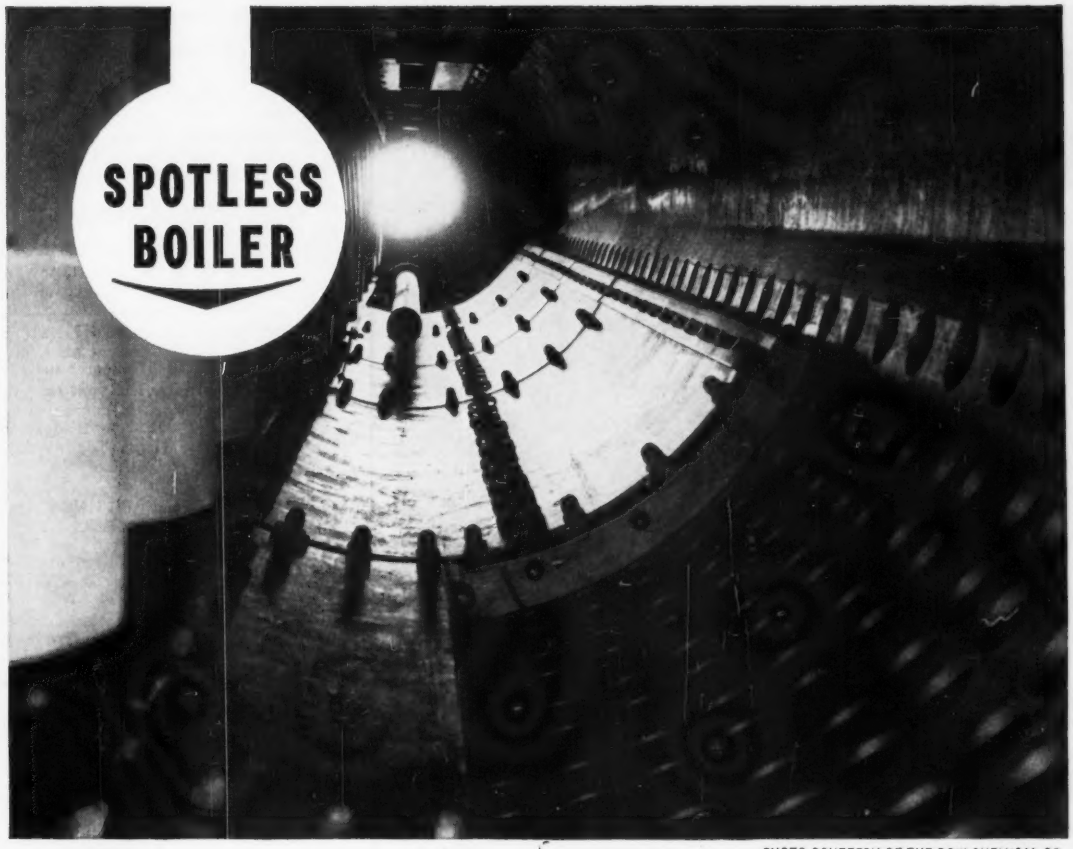
167 **Packaged** forced-draft firing systems are illustrated in 4-p bulletin 5843. Gives info on nine installations. Iron Fireman Manufacturing Company

MATERIALS HANDLING

168 **Coal breakers,** crushers are covered in 38-p bulletin 658. Description, photo, recommended drive data, dimensional drawings and capacities are given for each unit. McNally Pittsburgh Mfg Corp

continued

For more facts circle 256 on Reader Service Card, p 100



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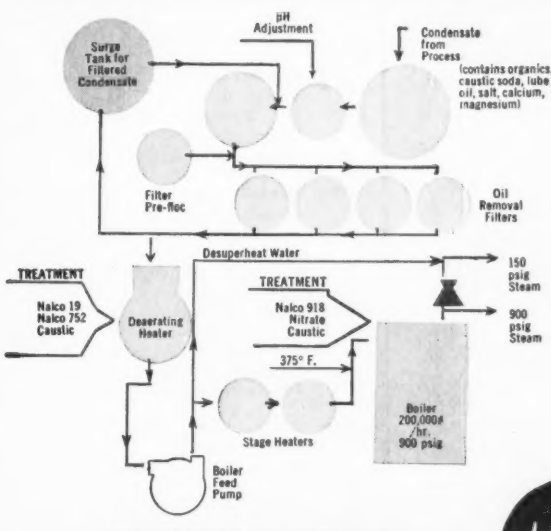
even though it operates on Contaminated Condensate!



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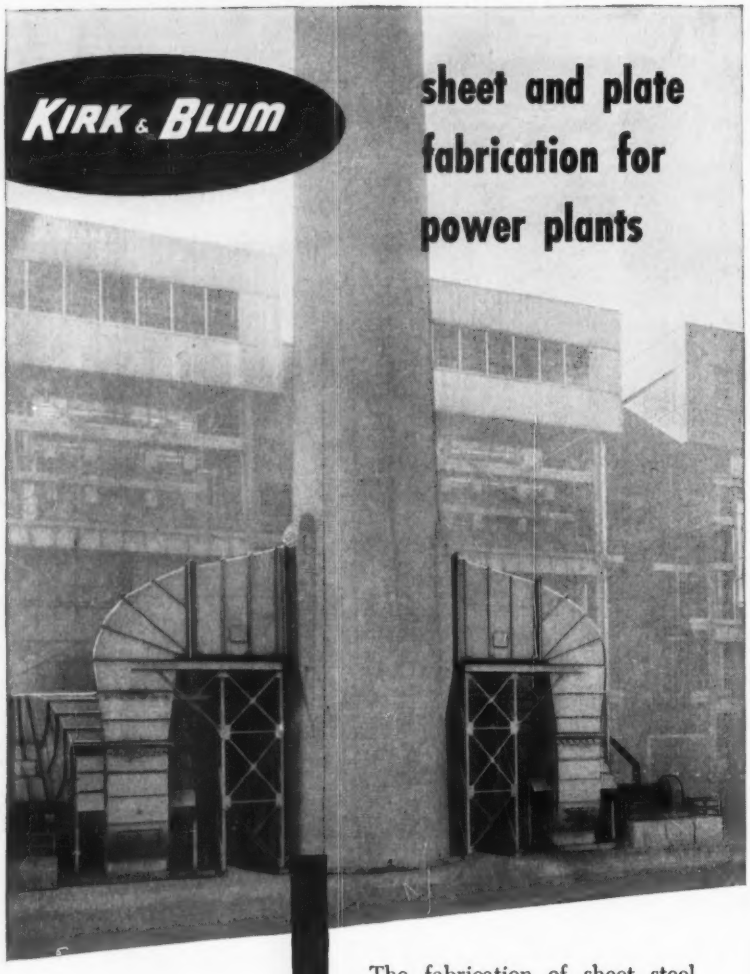
For more facts circle 257 on Reader Service Card, p 100



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Free literature

Begins on page 99

169 **Coal feeding** and weighing system is subject of 16-p catalog. Installation photos are given, plus diagrams, features. Bell Automation Corporation

PRIME MOVERS & AUXILIARIES

170 **Gas turbine,** 750 to 1000 kw, is described in 14-p bulletin 167. Design features, fuel types, applications are described. Clark Bros Co

171 **Air-jacketed** silencers to suppress engine noise, ventilate the engine room are discussed in 4-p brochure D-192. Gives descriptions, applications for nine models. The Maxim Silencer Co

VALVES, PIPING, FITTINGS AND SPECIALTIES

172 **Control valves** are covered in 12-p booklet LB-3. Construction, operating characteristics are given for the 600-lb ASA-rating units. Conoflow Corporation

173 **Medium-pressure** hydraulic-hose and tube assemblies are listed in 36-p bulletin 100. Dimensional drawings and tables of available sizes included. Eastman Mfg Co

174 **Manifold distribution** systems for continuous distribution of industrial gases are discussed in 28-p brochure N-125. Systems for piping oxygen, hydrogen, helium, argon, acetylene are included. Chemetron Corporation, National Cylinder Gas Div

175 **Connectors** for flexible metal hose are illustrated, described and individually priced in complete 16-p catalog 658. Specs are included on wet-heat connectors. Cobra Metal Hose

176 **Bronze, globe,** angle, check, gate valves are listed in 12-p catalog. Pressure ratings, uses, features are given for a wide size range. Ohio Brass Company

177 **Conduit pipe fittings** of rigid aluminum are detailed in 8-p catalog 205. Specs are listed for the lightweight units. Conduit Nipple Manufacturing Company

178 **Y, basket strainers** for all services are listed in new catalog. Pressure-drop charts are also available. The Mueller Steam Specialty Company

179 **Valves** with Teflon seats, disks are illustrated in bulletin 11. Globe, Y, check, needle and plug-gate designs are covered. Alloy Steel Products Company, Inc

180 **Surface-wash** water valves for filters are subject of 4-p technical bulletin W-17. Operating layouts, construction and dimensions are included. Golden-Anderson Valve Specialty Co

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Equipment design of the month

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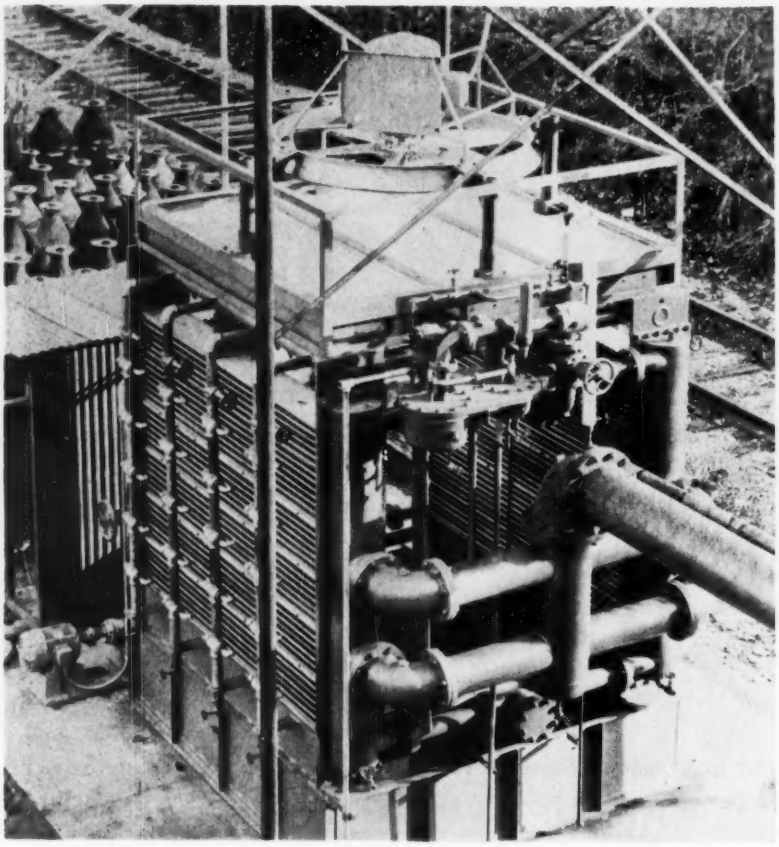


By STEVE ELONKA
Associate Editor

Unveiling the new . . . evaporative condenser

At long last, an evaporative condenser that uses no water—or only a little. It provides for proper pressure drop, air release and ejection; minimum subcooling of condensate; and is capable of continuously maintaining a predetermined vacuum—in fact, all features that are required of a surface condenser.

Developed by the Graham Manufacturing Co, Inc, it's called the Graham *Aquamizer*. Novel feature is that it's self-contained with recirculation and pump equipment mounted within unit. At 76-F wet-bulb temperature and 27 in. vacuum, capacity is 8700 lb steam per hr.

Some of the condensate is used as makeup water. Tube banks are on either side and air is drawn through tube banks, and discharged at top. Variable-pitch fans take care of load changes. Manufacturer feels unit is more than competitive with conventional surface condensers even if very low-cost water is available.

Photo shows test unit without cover and with piping used only for acquiring performance data. At 28-in. vacuum, condensing temperature is 101.1 F; noncondensable outlet is 90 F; steam capacity is 5400 lb per hr; 100,000-scfm cooling air is required; pressure drop (steam in. hg) is about 0.058; and fan hp is 40.

With water being a critical problem in some areas, POWER feels that the *Aquamizer* will fill a definite need in the vacuum-condenser field. For further data on this condenser, circle No. 90 on Reader Service Card, p 100.

Refinery Power Plant Compares Bonnet Joints

No maintenance for Crane Pressure-Seal valve on 10-year high-pressure/high-temperature service

Ten years ago two 10-inch, high-pressure-temperature gate valves were installed in the power plant of a Midwest refiner. Each one was installed on a boiler lead line, where steam service is 900° F. at 1280 psi.

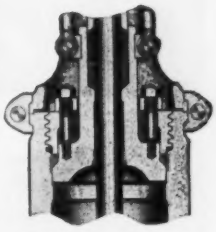
One valve is a conventional bolted bonnet type; the other, a Crane Pressure-Seal Bonnet Valve.

The bolted bonnet valve has required major maintenance four times in ten years because of bonnet joint leakage.

The Crane Pressure-Seal Bonnet Valve, during the same period, has never leaked . . . has needed no maintenance of any kind!

Conventional valves fight line pressure with heavy flanges and bolts at the bonnet joint. The bolting requires restressing and maintenance with each extreme change in temperature. Crane Pressure-Seal design harnesses line pressure to keep the bonnet joint tight despite extreme variations in temperature and pressure.

For complete information about Crane Pressure-Seal Bonnet Joint Valves—gates, globes, angles, stop-checks and swing-checks—in 600, 900, and 1500-pound classes—call your Crane Representative, or write to address below for new Circular AD-2336.



Here's the Crane Pressure-Seal Joint that eliminates bonnet joint leakage and maintenance on high-pressure-temperature services.

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Plant equipment news... Your

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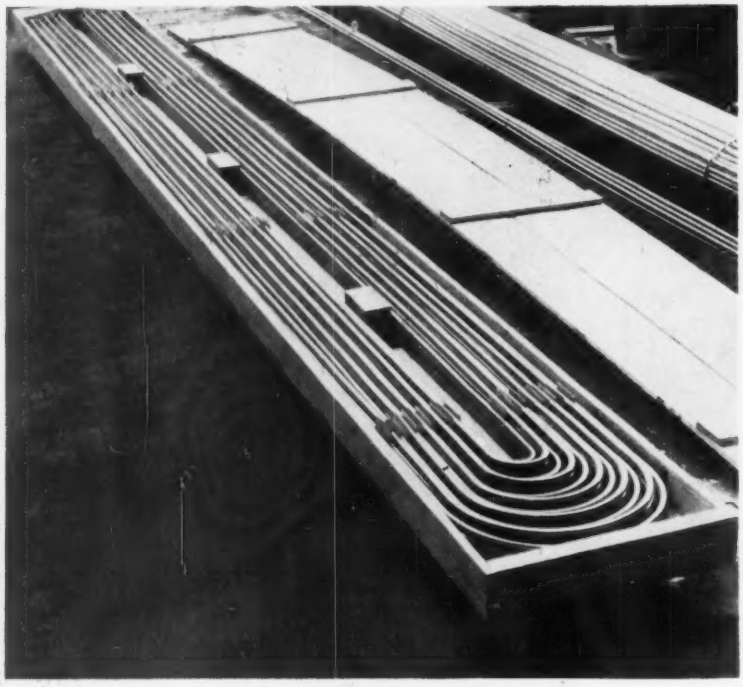
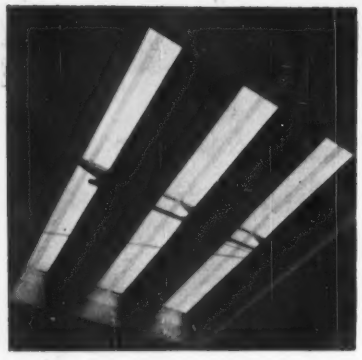


U-bend heat-exchanger tube now fabricated in factory

1 • U-bend tube, in many standard and custom gages, diameters and lengths, now comes direct from the manufacturer. It is available in uniform gage, or with thickened centers or thickened ends.

Factory fabrication means elimination of handling and equipment costs for on-site bending, less wastage, and an end to unnecessary handling and storage. The tubing is bent, trimmed, hydrostatically tested and reamed before shipment. Then tubes are crated and shipped on a disposable pallet to insure parallel leg alignment. Sizes are arranged and each tube is labeled to speed up on-site operations.

Standard U-bend tooling will accommodate straight lengths up to 75 ft in five gages ranging from .049 to .109 in., tube diameters from 5/8 to 1 in.—Chase Brass & Copper Co



Versatile ventilator doubles as skylight

2 • A high-capacity gravity roof ventilator that does extra duty as a skylight, the "Lite-'n-Aire" unit has translucent glass-fiber dampers and gutters to let in plenty of natural light. Use of fibrous glass makes dampers and gutters strong, nonwarping and resistant to damage from fumes and chemicals. With dampers open or closed, light is well diffused, without isolated hot spots and glare.

Ventilator can be used as the primary daytime light source in many applications. The 7½ in. by 10 ft unit has 30 cu ft of free air opening, but overall height is only 21½ in.

A fusible link parts when temperature gets above 212 F, automatically opening dampers to vent fire, smoke and gases. Unit moves large volumes of air quietly, efficiently and economically.—The Swartwout Company

Rugged roof ventilator boasts low profile

3 • Low-speed centrifugal type roof ventilator is built with a nonoverloading wheel and spun streamlined inlet complete with large access door, motor and V-belt drive. The 13 basic ventilator sizes feature various motor and drive combinations, totaling 111 catalog sizes. Each size is sound-rated for specific building environments.

Capacities run from 1120 to 34,440 cfm at free delivery to 26,540 cfm at 1-in. wg static pressure. True nonoverloading power characteristic is achieved by design of ventilator wheel—12 large-area die-formed blades mounted in a backwardly inclined position between a heavy-duty backplate and a die-formed rim. Cast-iron driving hub is riveted to the backplate for quiet, efficient operation.—American Standard, American Blower Div

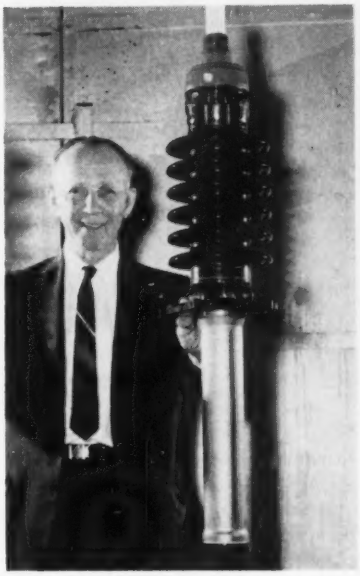
information center for new products and materials

Current-limiting fuse handles 14.4 kv and below

4 • Universal current-limiting fuse will take care of most indoor potential transformer needs at 14.4 kv and below. Unit fits all mountings and is not downward-voltage-critical. It can handle any system voltage down to 2.4 kv without impairment of interrupting ability and without inducing excessive transient overvoltages during interruption.

Unit's current-limiting section uses a helically coiled molybdenum wire. This wire is in turn helically coiled on a ceramic core, imbedded in silica sand. Interrupting section of fuse uses a time-tested boric-acid chamber.

Fuse comes in four ratings: 4.8, 7.2, 13.8 and 14.4 kv. There are two clip center sizes, 8½ and 11½ in. A 600-volt nonindicating style is also available, which has 4½-in. clip centers.—S&C Electric Company



H-v bushings interchange between transformers, breakers

5 • Standard h-v bushings come in eight sizes to cover all applications in voltage classes from 23 to 196 kv.

TBI (Transformer-Breaker-Interchangeable) bushings meet all ASA standards. Each unit has a dual current rating, 400/1200 amp in the 23- to 69-kv range, and 800/1600 amp in the 115- to 196-kv range. Current rating is determined by terminal accessories, so units can be converted from one application to the other simply by changing the terminal accessories.

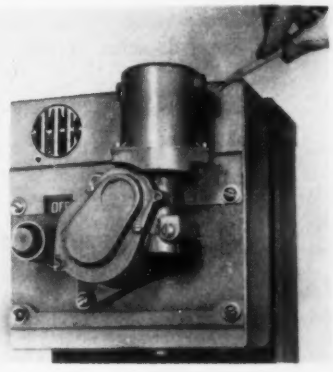
Bushings will be available on all company's power transformers, medium transformers and h-v circuit breakers early in '59. Main advantage comes in the shape of big savings in spare-bushing inventories. Better service in emergencies, simple ordering, lower price should be added features.—General Electric Company

Breaker operator allows remote control

6 • Motor-operated mechanism makes possible both remote control and automatic transfer systems using molded-case circuit breakers. Designed for flexibility, units can be wired for any systems desired, and can be mounted on the company's existing breakers without removing them from service. They add only 6 in. to the breaker's depth.

For use on breakers in switchboards, control centers and individual enclosures, units provide positive remote electrical actuation in continuous current ratings from 70 to 800 amp and voltages up to 600-volt ac and 250-volt dc. Features are high-speed operation, safe emergency manual operation, easy access to instantaneous trip adjustments, simple installation.

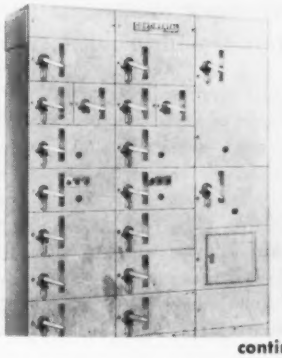
Automatic reset is optional. Auxiliary switch senses tripped position, energizes a circuit to reset the breaker.—I-T-E Circuit Breaker Company



Motor control center features flexibility

7 • Simpler maintenance, reduced time for changing individual control units are advantages of a new motor control center. Standing 60-in. high, basic structure holds 5 to 8 units in modulars of 9 1/3 and 14 in. Units and their multiples can be intermixed to meet any requirements.

Slide-guide mechanism is locked into the structure. Each modular unit is suspended from two top edges, and by releasing thumb controls on each side, plant engineer can draw unit out horizontally to two positions. In first position it's ready for testing, in second position it's set to be inspected or serviced. Unit locks in either position.—Continental Electric Equipment Co



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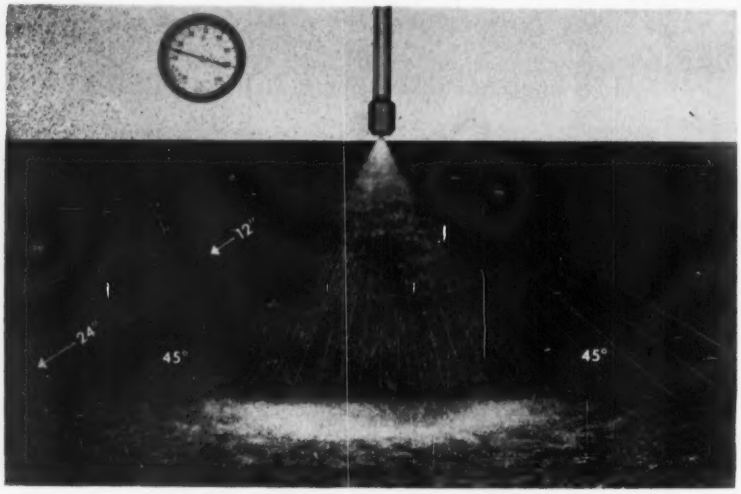
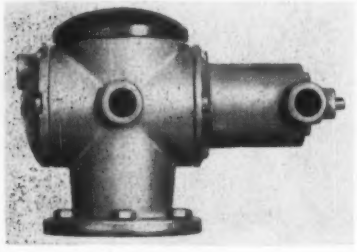


Spray nozzle produces uniform, solid cone

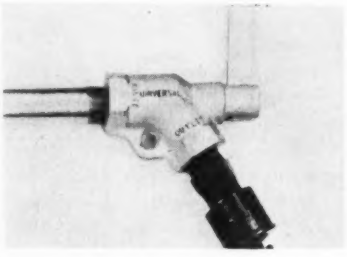
8 • General-purpose spray nozzle discharges large quantities of liquids at low pressures. Nozzles produce medium to coarse, evenly distributed, solid-cone sprays with a normal angle of 70 deg—a distribution pattern especially good for scrubbing fumes, cooling gases, gas-washing operations.

A ¾-in. nozzle with 7.5-mm orifice, operating with water supplied at 20 psig, produces a 70-deg angle with water capacity of 8 gpm, above. With 100-psig water, the same nozzle will produce a medium spray at 18 gpm. Nozzles are stocked in bronze and stainless steel; can be custom-made of Everdur, Monel or other special metals.—Schutte and Koerting Company



Valve positioner combines power with sensitivity

9 • Top-mounted integral positioner is capable of matching or exceeding speed and sensitivity of modern pneumatic controllers, maker claims. Force-balance design and a new pilot-operated relay valve combine to give high power output, maximum sensitivity. Enclosed, weatherproof unit is used on cylinder, diaphragm type actuators.—Conoflow Corp



Steel air-service valve features fast opening

10 • Positive shutoff is accomplished by means of a spring-loaded long-lasting rubber plug on this "stopple" valve. In closed position valve plug is held in place by means of line pressure and spring load. Position of handle, top right, shows whether valve is open or closed. Units have steel bodies, ¾-in. npt outlets.—Rutherford Company, Inc

Quick-coupling filter comes in all metals

11 • Extremely fine filtration with tough Monel metal or 316 stainless steel screens is feature of improved filter. Quick-couplers on inlet, outlet and body speed up cleaning operations on the reusable filter element.

Units have flanged, easily removable Monel or stainless screens. They are non-short-circuiting, and come in 20 to 700 mesh, pressures to 300 psi, temperatures to 450 F.

The filters can be used for prevention of nozzle plugging, to eliminate ferric oxide and pipe scale, for clarification of viscous liquids, for protecting hydraulic valves and flow meters. Elements will withstand as much as 150-psi differential pressure without collapse—Ronningen-Petter Company

Butterfly valve boasts improved seat retention

12 • New method allows seat retaining pressure to be externally adjusted with valve in place in the line. Only two seat-retaining screws are used, and these are not in contact with the flowing medium, to avoid any corrosion problem. Valve disk and rubber-seat arrangement at disk hub are designed to eliminate premature seat failure, according to maker.

Built and tested in accordance with AWWA specs, butterfly valves have rugged flanged bodies, precision-molded nylon-cloth-reinforced resilient rubber or synthetic seat, and heavy-duty corrosion-resistant operating parts.

Standard models are made for line sizes from 6 to 48 in., maximum line velocity of 8 or 16 fps, maximum shutoff pressures of 25, 50 or 125 psi. Manual or automatic operators are available.—F B Leopold Company, Inc

Circle key numbers on Reader Service Card, p 100, for complete product story

continued

So many ways the *FISHER/MAN*
can give you a helping hand with the

WIZARD II
PRESSURE CONTROLLERS

- Two Position Controller
- Proportional Controller
- Proportional Controller —Remote Set
- Differential Proportional Controller
- Pressure Transmitter
- Differential Proportional Controller— Remote Set
- Proportional Reset Controller
- Differential Proportional Reset

This "Jack of ALL Trades" is surprisingly low in cost

The partial list of applications at left tells you why the Wizard II is so aptly named. Probably no other controller in the Fisher line is as versatile. Available in brass, steel or stainless steel Bourdon tubes for ranges from 25 to 10,000 psi. Brass or stainless steel bellows available for low pressure service from 30″ Hg Vacuum to 30 psi.

Fisher has carefully designed each component of the new Wizard to satisfy the most rigid process control requirements. A completely descriptive and illustrated booklet on the Wizard II is yours for the asking. Write for Bulletin D 4150 A.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

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FISHER® Controls

SINCE 1880

For more facts circle 261 on Reader Service Card, p 100

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Management: International Exposition Co.
1261

Equipment news

Begins on page 112

Cleaning, descaling air gun

13 • A set of rapidly reciprocating steel needles strikes the surface being worked, rapidly removing rust, scale and dirt. Pistol cleans with little dust, operates on normal air pressure—not more than 90 psi, with air consumption at a maximum of 13 cu ft per min.

Needles conform to contour of the surface being cleaned, to effectively handle uneven surfaces. Nonsparking needles are available for cleaning in dangerous areas. Scrapers and chisels can also be adapted to the gun.—The Marindus Company

Oxygen comparator

14 • Quick oxygen reading in high-purity water is given by unit, using the indigo carmine method. Equipment consists of a rotating 6-color disk and support for sample bottle. Unit is made of Plexiglas, white to prevent color interference, and measuring 4x8x1 in.

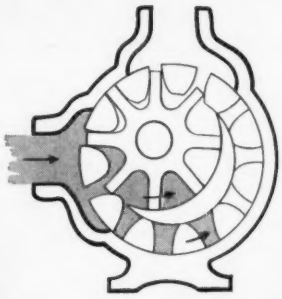
Disk gives matching colors for oxygen at 0, 5, 10, 15, 25 and 50 ppb. Price is $19.00.—R L Johnson

Just circle key numbers on the Reader Service Card, page 100, to get complete product story

Nuclear materials

15 • Exotic materials uniformly dispersed in a matrix alloy can be furnished to exacting specs of grain size, concentration. One custom component for nuclear control experiments is a 304 stainless-steel matrix with a uniform dispersion of 0.52% samarium oxide held to 5.3 mg per sq in., ±0.2 mg. This composite was

WHY are Viking rotary pumps BETTER?



BECAUSE they are Mechanically Superior

The Viking "gear-within-a-gear" pumping principle makes liquids flow into and through the pump, changing direction ever so slightly until liquids are trapped. This action cuts turbulence, foaming, cavitation and power consumption to a minimum. As a result, liquids are delivered in a smooth, positive flow . . . free of aeration.

TESTED

In test after test the superiority of Viking's pumping principle has been proved over other rotary pump action . . . and even more pronounced when handling fluids of 750 SSU and thicker. Learn the complete story on Viking rotary pumps. Send for free catalog 59SW.

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In Canada it's "ROTO-KING" pumps
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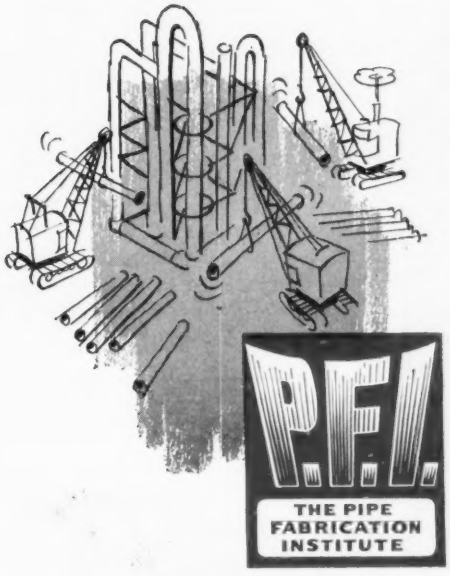

The gent in the helicopter would really be "up-in-the-air" if he couldn't find his P.F.I. Standards.

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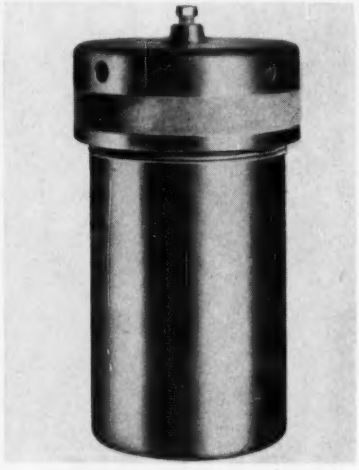
McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

Equipment news

Begins on page 112

supplied as foil in 4x12x0.008 in. size.

Other custom materials can be fabricated, with matrices such as aluminum, nickel, tin and dispersions of boron carbide, dysprosium oxide, zirconium boride, gadolinium oxide. —Sintercast Corporation of America

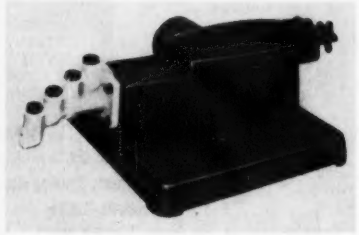


Filters for 3000 psi

16 • Laminated-fiber disk filters are designed for hydraulic and other h-p applications. They comply with the ASME *Code for Unfired Pressure Vessels*, and API or ASME *Code* inspection and stamping is available.

Units come in five sizes, from 1.5 gpm, 3-psi pressure drop to 47.6 gpm, 6-psi pressure drop, when filtering 100-ssu viscosity mineral oil. They can be connected in multiple. Inlet, outlet and drain are in filter's bottom.—Wm W Nugent & Co, Inc

Just circle key numbers on the Reader Service Card, page 100, to get complete product story



Controlled volume pumps

17 • Designed for the chemical processing industries, units use a minimum of working parts and bearing surfaces to translate high-speed rotary

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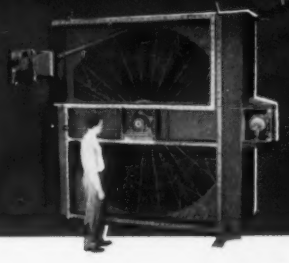
HERE'S WHAT YOU CAN DO ABOUT THE HIGH COST OF FUEL

GET MORE HEAT FROM EVERY FUEL DOLLAR WITH A

Ljungstrom® Package Air Preheater



By recovering heat from the exhaust gas, the Ljungstrom Air Preheater can increase combustion temperature as much as 400° or more! By raising furnace temperature this way, you permit more heat to be absorbed into boiler tubes or heat transfer surfaces. The results are increased capacity and greater output from every fuel dollar you spend.

And when you credit fuel savings, the installed cost of a Package Ljungstrom can be paid for in approximately two years.

You get maximum heat recovery because the Ljungstrom's exclusive rotary heat transfer element puts the heat back directly into the combustion air, i.e. without passing it through heat-absorbing partitions or tube walls. Package design also gives you all the advantages and economies of the Ljungstrom in a compact, pre-assembled unit. Available in vertical or horizontal models, Package Ljungstroms are readily adaptable to any plant arrangement.

For further information, write today for the free 14-page Package Ljungstrom manual.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

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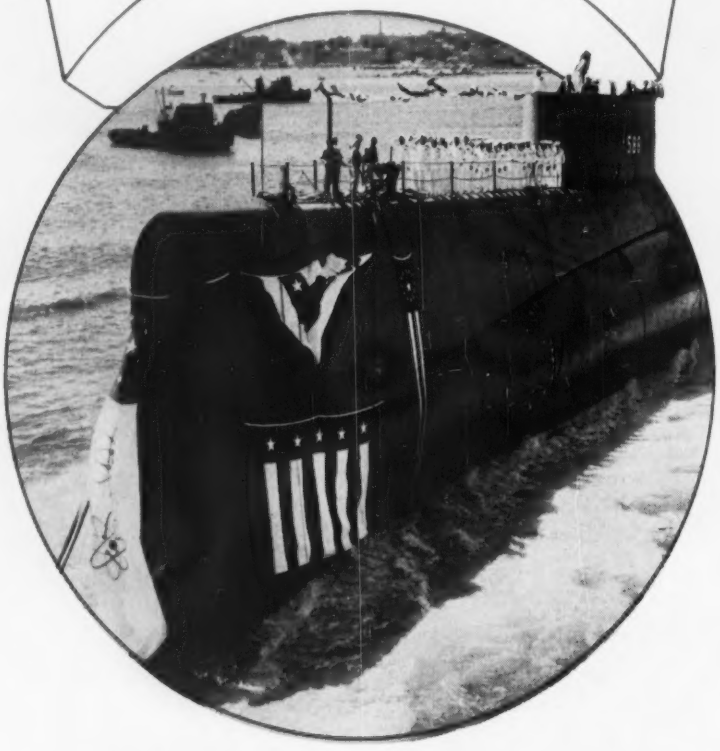
BONNEY WELDOLETS

for the world's biggest

ATOMIC SUBMARINE



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Bonney Weldolets featuring strength, improved flow conditions and easy, economical installation are used on the atomic-powered TRITON, world's largest and most powerful submarine. Launched in August, 1958 at the Groton, Connecticut shipyard of General Dynamic's Electric Boat Division, this twin-reactored sub—447 ft. long and displacing 5,900 tons—is scheduled for radar picket duty.

For detailed information about all Bonney Welding Fittings, call or write today!

BONNEY FORGE AND TOOL WORKS

ALLENTOWN, PENNSYLVANIA

Equipment news

Begins on page 112

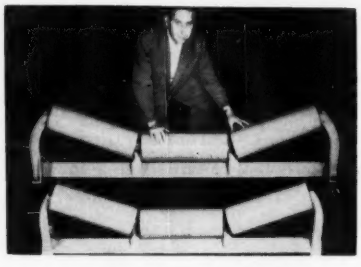
motion to low-speed reciprocating motion. Totally enclosed, speed reducer is an integral part of the pump and runs in an oil bath. Capacity can be adjusted from 0 to 100% by hand or automatically, while the pump is running.

Pumps have maximum capacities to 29 gph, and will meter against pressures to 1900 psi.—Milton Roy Company

Just circle key numbers on the Reader Service Card, page 100, to get complete product story

Instrument protection device

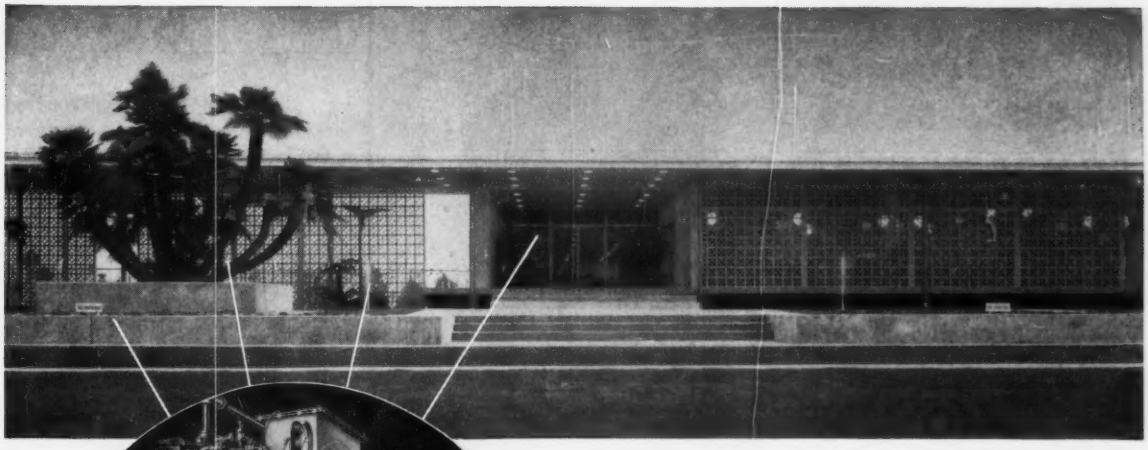
18 • Manometers, draft gages, electrical pressure switches are protected by this unit. Designed for atmospheric or relative-pressure system applications, it is repeatable and will reopen after sealing at 2% below cut-off point. Four ranges cover a span of −15 to +85 psig.—Industrial Engineering Corporation



Belt conveyor idlers

19 • Offered in five series and in widths ranging from 14 to 84 in., new line includes 630 different types and sizes.

Flat, 20-deg and 45-deg troughed idlers are available, plus cushioned idlers for use at loading points, positive-action and actuating disk train-



Screened facade of Stuart Co. plant, Pasadena, California

Iron Fireman-Kewanee boiler-burner unit

Where the *steam* comes from...

for both heating and pharmaceutical processing

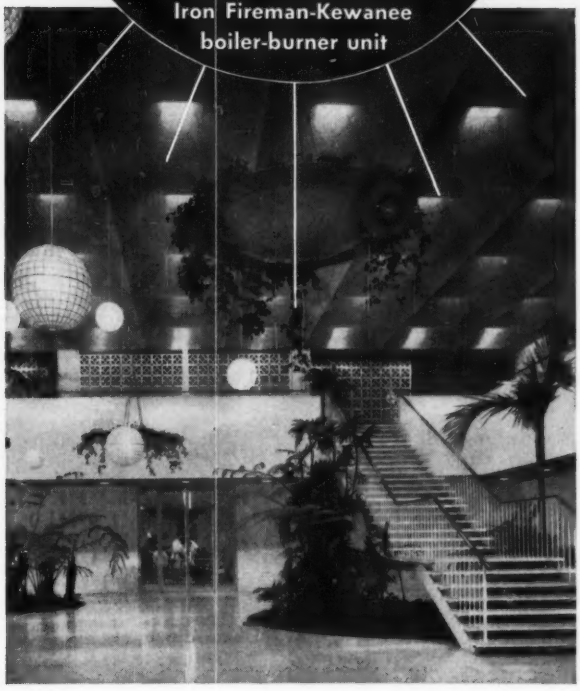
One of the notable commercial buildings of the year combines maximum utility with such striking beauty that it has won nation-wide acclaim. Designed by Edward D. Stone, this plant is used by the Stuart Co. for the production of pharmaceuticals.

Up-to-the-minute mechanical equipment includes two Iron Fireman-Kewanee boiler-burner units. Due to forced draft firing, there is no stack to mar the symmetry of the building. Dual-fuel burners efficiently fire gas or any grade of light or heavy oil, with quick changeover.

Complete Iron Fireman boiler-burner units can be easily sized, specified and ordered from a single catalog, with a single model number.

Conservative rating permits an easy, economical "cruising speed" at rated output, with 50% reserve capacity and consequent minimum noise level and low maintenance costs.

Mail coupon for detailed information and specifications.



Lounge and offices overlook spacious atrium

Architect: Edward D. Stone

Mechanical Engineers: Stockly & Bamford

Mechanical Contractors: Hickman Bros., Inc.

IRON FIREMAN®

AUTOMATIC FIRING EQUIPMENT FOR HEATING, PROCESSING, POWER

IRON FIREMAN MANUFACTURING CO.
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Please send catalog and specifications on following equipment:

- ☐ Complete boiler-burner units
- ☐ Forced draft firing unit only

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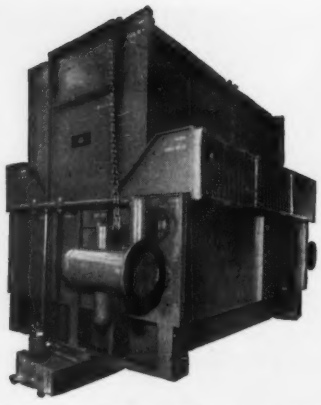
ECONOMICAL COOLING OF GASES AND COMPRESSED AIR



Cooling gases or cooling and removing moisture from compressed air, the Niagara *Aero* After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point below the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight, installation labor and upkeep. Niagara *Aero* After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130.

NIAGARA BLOWER COMPANY

Dept. P-1, 405 Lexington Ave., New York 17, N.Y.

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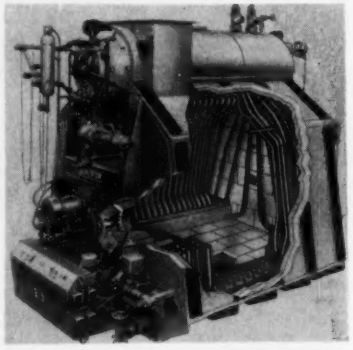
Maybe we don't have your complete address. A complete address includes a Postal Zone Number.

POWER • 330 West 42nd Street New York 36, N.Y.

Equipment news

Begins on page 112

ing idlers, and variable-troughed ones. All units are filled with grease at the factory; can be installed without further lube.—Link-Belt Co

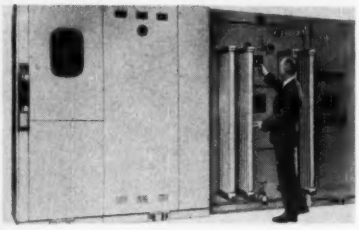


Packaged watertube boiler

20 • Capacities ranging from 4000 to 13,000 lb of steam per hr are produced by this fully packaged boiler. Efficient heat transfer without baffles or gas-collecting pockets has been achieved. Tangent tubes in furnace wall eliminate refractory baffle between furnace and convection-tube pass of boiler.

Mechanical draft fan is mounted at boiler's rear, leaving firing front uncluttered and giving positive air cooling of furnace floor and front firing wall. Rotary burners are standard, providing automatic operation, maximum safety. — Superior Combustion Industries, Inc

Just circle key numbers on the Reader Service Card, page 100, to get complete product story

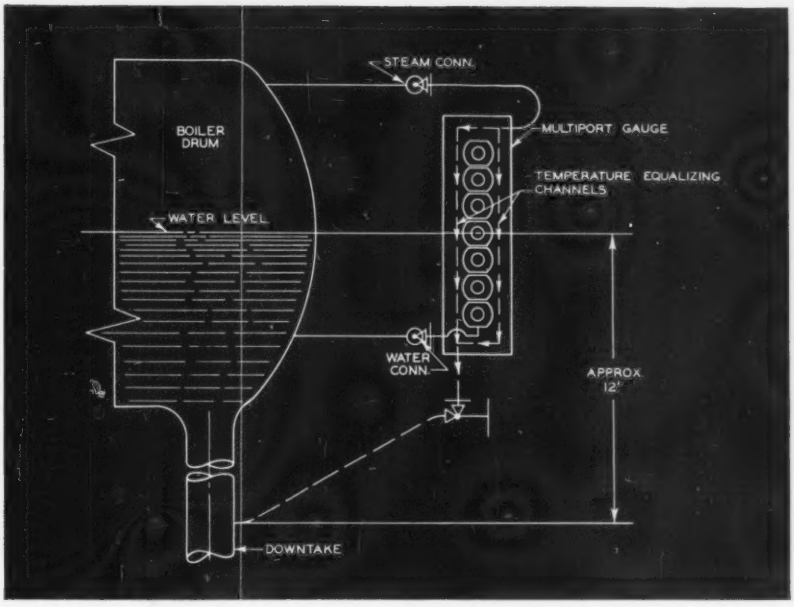


Packaged substations

21 • Completely pre-engineered load centers for stepping down primary voltages contain both transformer and its primary protective and secondary distribution devices.

Extended line offers units in ratings from 45 to 3000 kva for stepping down primary voltages from 2.4

ANOTHER NEW GAUGE DEVELOPMENT BY Diamond



Diagramatic illustration of new Diamond Temperature-Equalizing Multi-Port Gauge installation.

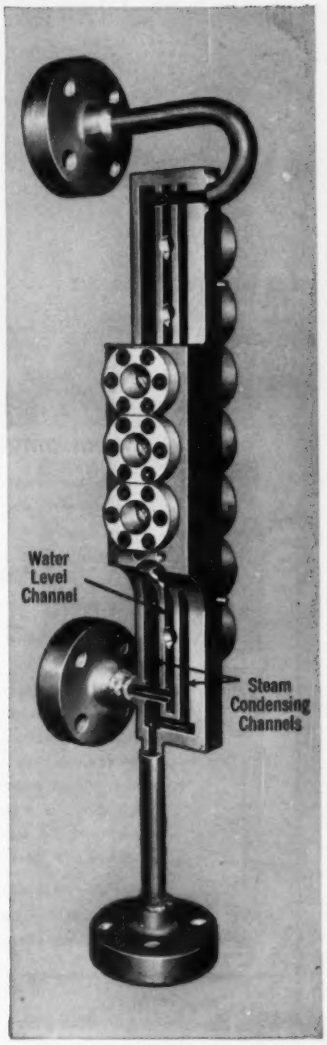
The need for correction of inherent gauge error at high operating pressures is well recognized, but heretofore no satisfactory simple answer has been found. Now, Diamond has developed the Temperature-Equalizing Multi-Port Gauge* to reduce the error in gauge level reading by a simple and fully reliable means.

Gauge error (resulting from the gauge temperature being lower than boiler saturation temperature) is substantially avoided by introducing supplementary gauge heating in the form of steam condensing channels. These channels are parallel to the gauge water level channel as illustrated, and serve to heat the gauge level channel by direct conduction of heat from condensing steam through the gauge body itself. No external source of energy or control is required. The heating channels have a natural circulation system independent of the gauge level channel so that no faulty operation can occur under any circumstance.

Ask your local Diamond office or write directly to Lancaster, Ohio for Form 2150U for further information.

*Patent Applied For

8031



Cut-away sections illustrate independent gauge body heating channels of the new Diamond Temperature-Equalizing Multi-Port Gauge.

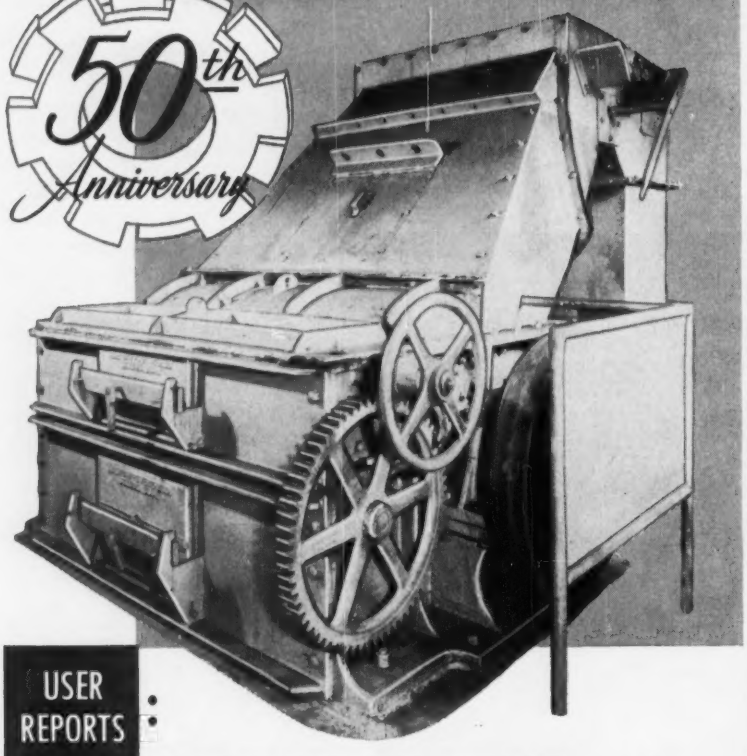
DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED—Windsor, Ontario

For more facts circle 272 on Reader Service Card, p 100

OVER 4,000,000 TONS OF COAL REDUCED BY AMERICAN ROLLING RING COAL CRUSHER

50th Anniversary



USER REPORTS

"A VERY EFFICIENT CRUSHER; *requires a minimum amount of maintenance.*"

A Midwest Power Plant engineer made this comment and gave the information below about the operation of their American AC 3-E Rolling Ring Coal Crusher.

Total Tonnage Reduced	Over 4,000,000 tons
Feed	20% Nut (3" x 1½") 80% Screenings (1½")
End Product	Minus ½"

Performance reports like this are standard on American Crushers. Each crusher is custom-built to suit your requirements. The American performs as an efficient crusher, producing high tonnage at slow operating speeds — saving power and maintenance. The manganese steel shredder rings are reversible for double life, crushing chambers have renewable liners, and housings are sectional for easy accessibility to rotor, and machined for a dust-tight fit. These, and many other features have been developed throughout 50 years of experience.

Our engineers will analyze your reduction problems and make recommendations of the correct size and type of crusher. No obligation, of course. Write for literature, stating your tonnage requirements.

"When you figure costs—the best results come from American Rolling Ring Coal Crushers"

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

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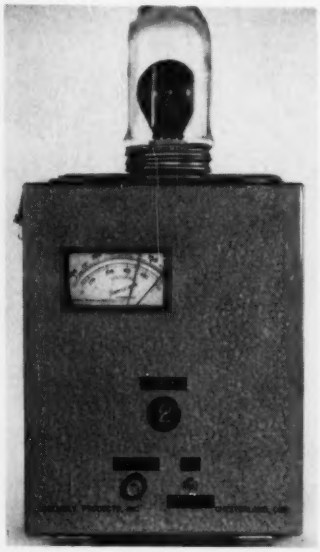
Equipment news

Begins on page 112

through 13.8 kv to 208/120 through 600 v. Oil-filled, askarel-filled, sealed or ventilated dry types are available. —I-T-E Circuit Breaker Company



Scanning control

22 • Unit can monitor up to 24 stations in sequence. It instantly indicates an abnormal condition at any point by a red warning light and an alarm, if desired, and can be set to shut down equipment being monitored. Number of the station affected is shown in a Burroughs tube.

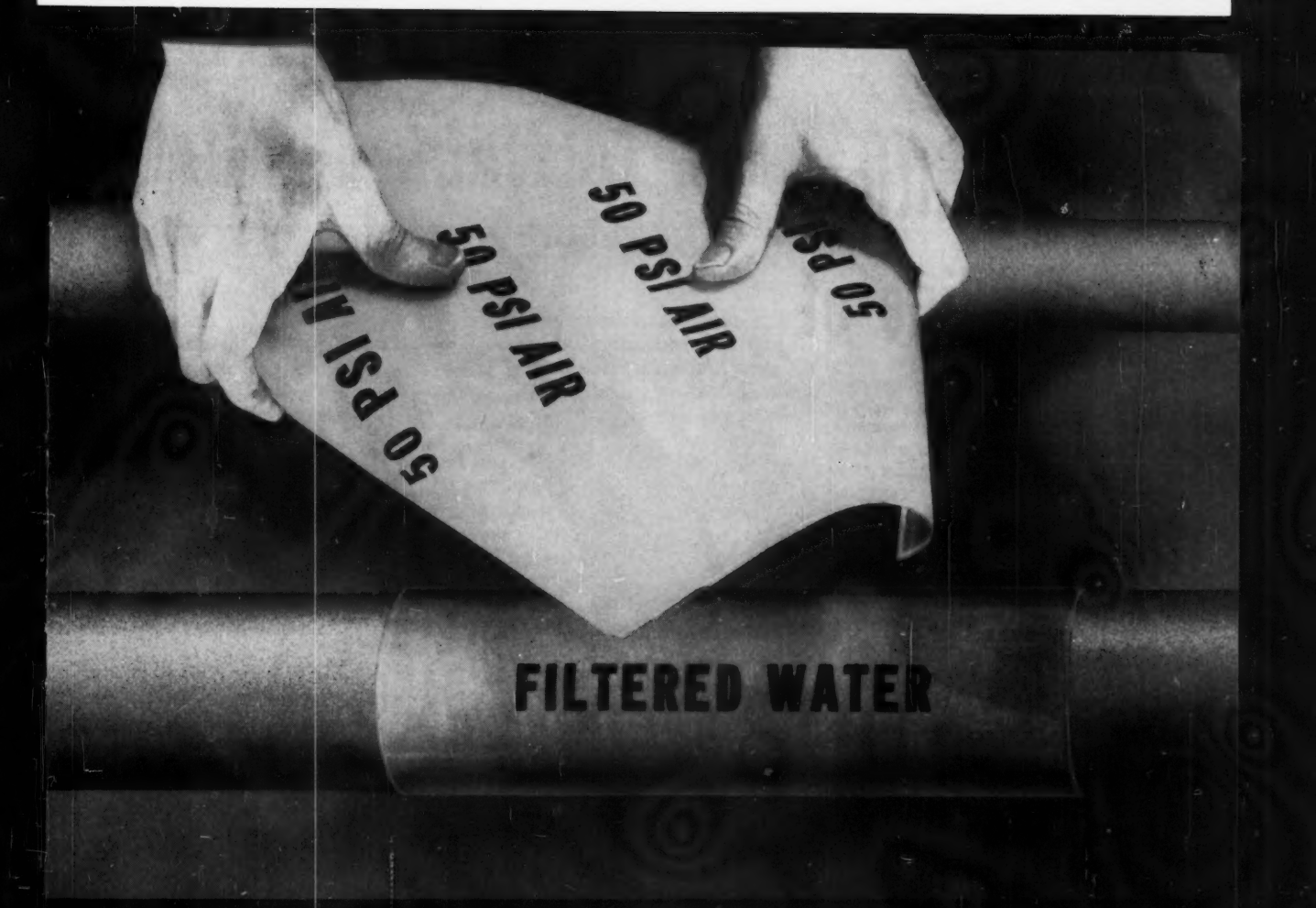
Developed for watching temperatures from –200 to +3000 F, scanner can monitor most measurable variables. A selector switch checks stations in order, 12 per minute. Signals are indicated continuously, by a moving pointer, and alarm goes off if indicator touches high or low limits.—Assembly Products, Inc

Electric sequence controller

23 • Unit is said to achieve automatic sequence control of electric motor driven equipment without use of telephone-type relays. Equipment is strong, simple, easily maintained.

Control signals and full motor current are taken through sequence distributor. Distributor is suitable for operation on 440-v 3-phase supply. —Jones, Tate & Co, Ltd

Just circle key numbers on the Reader Service Card, page 100, to get complete product story



ANKOR PIPE IDENTIFICATION BANDS

An economical method for instant identification of pipe lines . . .

JUST OPEN . . .

The permanently shaped vinylite label is easily placed in position—no tools required.

AND SNAP ON!

When you let go, pipe label snaps itself instantly into place.

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ANKOR SAFETY FLANGE SHIELDS

A Safety Factor in processing corrosive and dangerous liquids, designed to completely cover the pipe flange —unbreakable—can be used many times. No tools needed to install.

ANKOR SAFETY VALVE BONNET SHIELDS

Cover both packing gland and bonnet flange. Made in two halves and fastened together with snap buttons, the Bonnet Shield can be installed in one minute; removed in one second, without removing hand wheel or other valve parts. Semi-transparant, so that trouble spots can be located without removing the shield.

Find It Fast in the "Yellow Pages"

THE ANCHOR PACKING COMPANY

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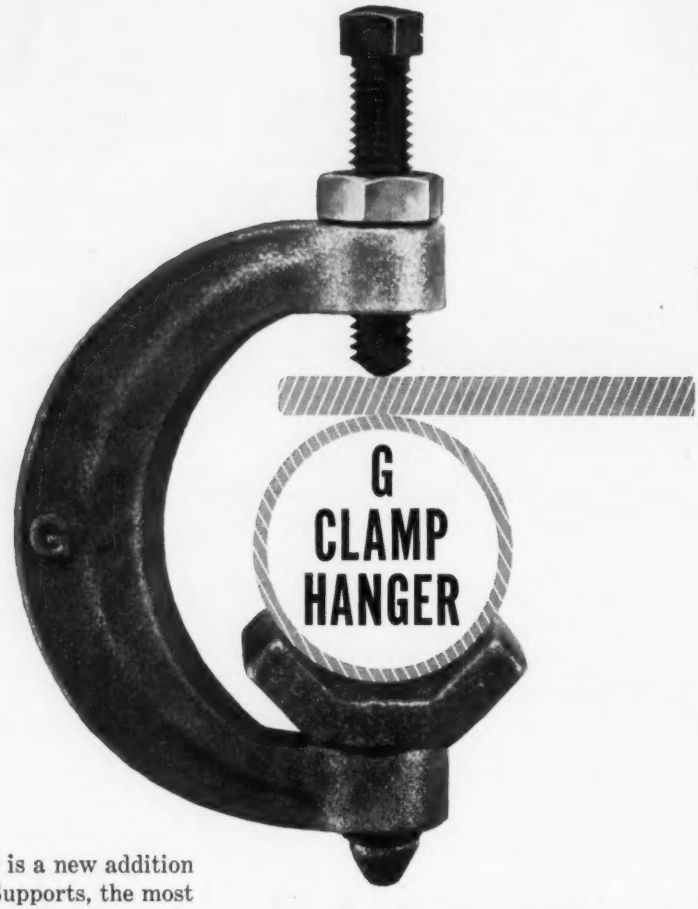
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

New addition to the line of Grinnell malleable iron hangers



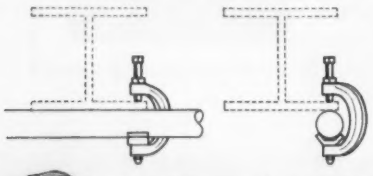
Grinnell's Malleable Iron G Clamp Hanger is a new addition to the line of Grinnell Pipe Hangers and Supports, the most complete line of any manufacturer. This hanger answers a long-felt need for support of pipe or conduit (up to 4 inches in size) where application can be made directly under structural steel.

The saddle of the Grinnell G Clamp swivels. This permits pipe or conduit to be installed either parallel or traverse to the beam axis. Separate beam clamp, rod and pipe clamp are not required, thus saving cost of supports and installation time.

Grinnell G Clamps are made of malleable iron with a ribbed design for added strength. The set screw has a hardened steel cup point for clamping rigidly to beam. Full thread engagement is provided by the tapping through the upper jaw. Approved by Factory Mutual Laboratories for use on fire protection and plumbing systems. Especially recommended for hanging conduit. Maximum recommended loads are from 210 to 450 pounds, for the smallest to the largest sizes, with a safety factor of 5.

Every Grinnell Malleable Iron Hanger offers . . .

- Safety factor of at least 5
- Thickness of metal increased at points of concentrated stress
- Homogenous metal composition throughout
- Extremely high resistance to impact and corrosion
- Economy



Saddle swivels, permitting suspension of the pipe or conduit at any angle in a plane parallel to the face of the supporting flange.

GRINNELL
AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPLIES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

Hall Industrial Water Report

VOLUME 7 JANUARY 1959 NUMBER 1

Let's Get This Clear

Day after day new products are being developed to improve the clarification of water. The standard coagulants, aluminum and iron sulfates, have long been supplemented with aids like clay and magnesium oxide. Some 20 years ago Baylis developed activated silica. But today new materials to assist clarification with the standard coagulants are coming along faster and faster. They are designed to improve removal of color, bacteria and suspended material from potable and industrial water, to cut costs by reducing coagulant consumption, to assist in removal of deleterious materials from waste water and to assure optimum operation of clarifiers and filters.

Hall Laboratories research and development continually provides improved coagulant aids, field tested for performance. Furthermore, Hall engineers know clarification equipment and processes. They are ready to help you improve clarification or reduce water treatment cost.

Feeding Ferric Sulfate

Ferric sulfate is a commonly used coagulant. When fed with a solution feeder, care must be taken to get the chemical completely into solution. Otherwise, undissolved material will cause trouble in the feeding equipment and effectiveness will be lost.

Each pound of ferric sulfate liberates about 260 BTU when it goes into solution. The resulting solution temperature increase has an important effect on rate of solution. If tap water temperature is too low, or if the ratio of water to ferric sulfate is too high, there will be troublesome undissolved material. Furthermore, final solution temperature should be 90°–100° F.

The practical trick for easy handling is careful adjustment of the water-to-chemical ratio. If water temperature is 68° F., dissolution of ferric sulfate will be complete in 18 minutes and final solution temperature will be about 98° F., if the ratio of water to solid ferric sulfate by weight is five. If water temperature is only 47° F., the solution rate and final temperature will remain the same, provided the ratio of water to chemical is cut to three. These examples may be used as a guide; obtain complete dissolving information from the manufacturer of the material used.

Water Color Problem

An Eastern woolen mill is located downstream from other woolen mills, a steel mill and a sewage plant. Needless to say, the river water is badly contaminated with organic coloring matter, suspended matter and detergents during summer droughts and extremely cold weather. Clarification has been difficult. Even with heavily increased alum dosages color removal was poor. This was a costly situation because it frequently necessitated reprocessing of the delicate pastel shades which are a specialty of this mill.

More than two years ago Hall Laboratories introduced the plant to coagulant aids. After laboratory jar tests were carried out to determine the type of aid best suited to this particular case, the plant adopted the use of a Hagan aid during periods of high color. Not only have floc formation, sedimentation and color removal been greatly improved, but alum dosage has been reduced by 25%. The plant operators say they feel sure they would have had to suspend operations during the 1957 drought if they had not been using the Hagan coagulant aid.

No Clarifier Needed

A growing Southern textile plant was forced to curtail operations because water requirements exceeded the total capacity of the wells. Further expansion was anticipated. The additional water required would have to come from a surface supply.

Faced with the installation of expensive clarification equipment and costly chemical treatment to make the water suitable for process work, the plant called on Hall Laboratories to study the problem. Hall engineer R. E. Elliott carried out the survey and came up with a money-saving answer. He found that a lot of water could be saved by re-using cooling water from closed heat exchangers, by repairing overflow mechanisms and by using untreated surface water for non-critical operations. No treatment of surface water would be necessary and enough good quality well water would be saved to permit *doubling* current operations.

Potential Trouble

When Hall engineer Peter Benes began service work at a Southern chemical plant he found a clay-like deposit accumulating in the sodium cycle units of the split-stream softeners. Because of previous bad experiences with aluminum in boiler water, Benes became alarmed when analysis showed the deposit to contain considerable aluminum.

Further analytical work traced the aluminum to the clarified and filtered makeup water. Clarification was accomplished with aluminum sulfate; but operation and pH value were such that there should have been very little aluminum in the filtered water. Benes kept digging. He found that soda ash, used to adjust upward the pH of the clarified water, was being added ahead of the filters. This resulted in dissolution of some of the small amount of suspended aluminum hydroxide floc passing to the filters.

Immediate change was made to feed the soda ash after the filters. Aluminum concentration of the filtered water dropped from 0.15 ppm to 0.05 ppm and the problem was solved.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

HALL LABORATORIES
DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.
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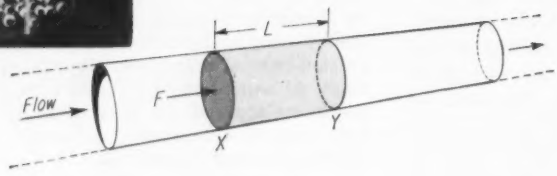
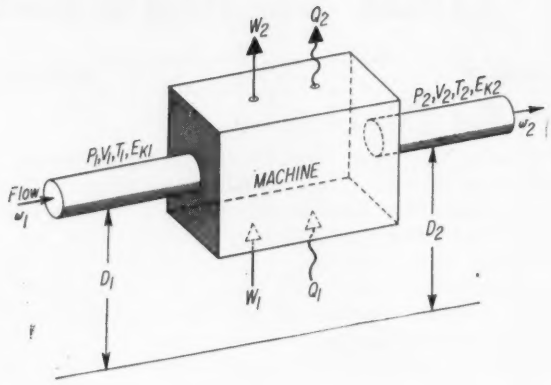
Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

THERMO REFRESHER NO. 23



1 Net force acting on fluid flowing in pipeline transmits energy that resides in the fluid when it moves. This is flow work



2 Steady-flow energy equation centers on machine that receives and discharges energy in many forms; w_1 always equals w_2

Most of our thermodynamic machinery uses steady flow of the working fluid. We analyze these machines with much of the information we learned for nonflow, but need a few extra ideas that we introduce here. As always . . .

By B G A SKROTZKI
Associate Editor

Energy in must equal energy out

We have studied the nonflow processes of gases based on certain simple ideas that we talked about in Parts 7 and 8, POWER, April and May 1957. From these we built up an analysis of the operation of reciprocating machinery such as air compressors and internal-combustion engines. Now we're ready to deal with steady-flow processes.

Flow work. Machines such as turbines, compressors, furnaces, pumps, fans, air coolers, heat exchangers handle a steady flow of fluid. This usually enters the machine through a pipe or duct and leaves through a pipe or duct, Fig. 1.

Ordinarily the fluid moves in the entrance pipeline because space ahead of it is being opened by the machine constantly removing the fluid from the entering pipeline at the machine impeller. The fluid moves through the discharge pipeline because the impeller forces it into the discharge opening and so forces fluid ahead of it. The fluid can only move if the fluid ahead has space to move into.

For some machines the impelling force may simply be the initial pressure of the fluid itself in the machine. No matter how this flow is created, the fluid moves because there is more pressure behind it than ahead of it. As a result there is a net force that moves it through the pipeline.

In Fig. 1 we have a continuous pipeline filled with fluid and for study choose a 1-lb slug of it occupying the length L between planes X and Y. A net force F moves this slug (and all the slugs ahead of it). But as this force F acts on the slug it moves through a distance, and a force moving through a distance acting on a body does mechanical work. The fluid possesses this energy since the work is done on it, and it can transfer this work to any object in its path. This energy is called *flow work*. As soon as the fluid stops flowing it loses any flow work it had.

Now let's see how we can measure it. The work done on the slug in Fig. 1, is the flow work in ft-lb:

$$W_f = FL \qquad (1)$$

But the total net force acting is PA where A is the cross-sectional area of the fluid in sq ft. Then:

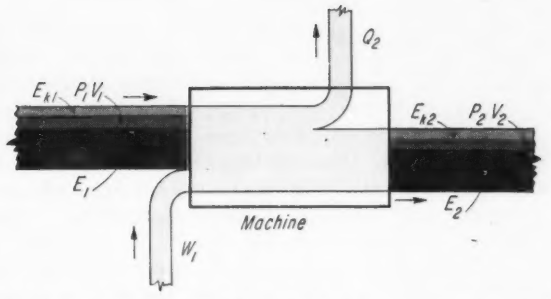
$$W_f = PAL \qquad (2)$$

but AL is the volume of the slug of fluid V so:

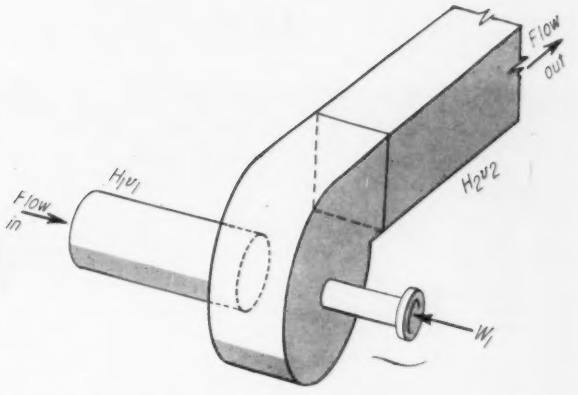
$$W_f = PV \qquad (3)$$

Then the flow work of any pound of moving fluid is simply the product of its absolute pressure in psfa and its specific volume in cu ft per lb. In one sense we can regard flow work as the ability of a fluid to transmit energy from the source of pressure or force. This term, of course, does not apply to any of the nonflow processes.

Kinetic energy. Never forget that flow work is associated with the force transmitted through the fluid. A moving fluid, however, also has kinetic energy because of its motion. Work had to be done in moving it



3 Energy-flow diagram helps visualize the quantities involved and emphasizes the exact balance between energy in and out



4 Mechanical work input to fan shaft adds energy to air or gas flowing through unit by raising enthalpy and velocity of fluid

from rest, and it can give up this energy by doing work on something else that brings it to rest, see Part 1, August 1956, p 100.

The kinetic energy of a mass of fluid is given by:

$$E_k = \frac{wv^2}{2g} \qquad (4)$$

where E_k = kinetic energy, ft-lb
w = weight of fluid, lb
v = fluid velocity, ft per sec
g = acceleration of gravity, ft per sec^2

This energy is separate and distinct from flow work, so be careful not to confuse the two energy forms.

Potential energy. In Part 1 we also discussed potential energy. It is measured by the mechanical work a body can do in falling from a high elevation to a lower elevation. We figure it as:

$$E_p = wD \qquad (5)$$

where E_p = potential energy, ft-lb
w = weight of fluid, lb
D = vertical distance between elevations, ft

This also applies in nonflow processes, but change in elevation usually is so small that it can be neglected. In most steady-flow processes we'll also find that E_p is so small compared to the other energy forms that we can neglect it without error.

Mass flow. Fig. 2 shows a steady-flow machine receiving a constant flow of working fluid and exhausting an equal amount through the discharge line. The inlet and discharge lines may be of different areas, A_1 and A_2; the inlet and outlet velocities will probably be different, v_1 and v_2; and the inlet and outlet states as measured by the specific volume will also differ, V_1 and V_2. Then for constant mass flow rate through a machine, in lb per sec:

$$M = A_1v_1/V_1 = A_2v_2/V_2 \qquad (6)$$

If inflow and outflow are different in mass or weight, then, of course, equation (6) does not apply.

Steady-flow energy equation. With the energy forms we have used for nonflow processes and the new ones we have learned or reviewed we can list those to be applied to steady-flow processes:

a. Potential energy	E_p
b. Kinetic energy	E_k
c. Flow work	W_f
d. Internal energy	E
e. Mechanical or shaft work	W
f. Heat	Q

In Fig. 2 we show a machine, schematically, that receives and discharges a fluid at constant mass rate. To satisfy the first law of thermodynamics the energy that enters the machine must equal the energy that leaves it, providing that no energy accumulates in the machine and no stored energy in the machine drains off. This is true of most thermodynamic machines in practice, once they carry a steady load.

We can express this first law in the steady-flow energy equation:

$$E_{p1} + E_{k1} + W_{f1} + E_1 + W_1 + Q_1 = E_{p2} + E_{k2} + W_{f2} + E_2 + W_2 + Q_2 \qquad (7)$$

All of these energy quantities must be in the same units, for example, Btu per lb. So when we evaluate the individual terms they must be alike. In this complete equation, if we know 11 terms we can figure the 12th unknown. For our purposes we can immediately simplify equation (7) by noting that in any machine we deal with the change in E_p can be ignored, so we'll drop it from further discussion.

Substituting the property terms in (7) we get, in terms of Btu per lb:

$$\frac{wv_1^2}{2gJ} + \frac{P_1V_1}{J} + E_1 + W_1 + Q_1 = \frac{wv_2^2}{2gJ} + \frac{P_2V_2}{J} + E_2 + W_2 + Q_2 \qquad (8)$$

This outlines the information we must have to analyze the operation of a machine.

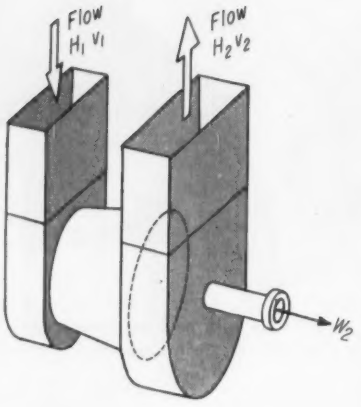
Enthalpy. The two properties internal energy E and flow work PV/J appear in combination so often that we find it convenient to combine them into one. So *by definition*:

$$H = E + PV/J$$

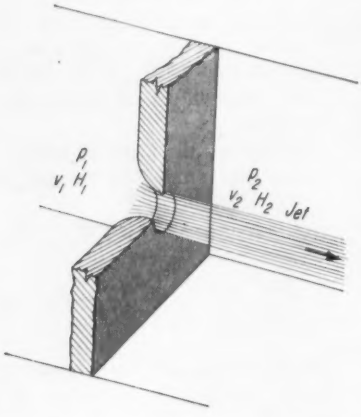
where H is the *enthalpy* in Btu per lb, a combination property of a fluid —and it only applies when the fluid *moves*, with some exceptions. Then our steady-flow equation reduces to:

$$\frac{wv_1^2}{2gJ} + H_1 + W_1 + Q_1 = \frac{wv_2^2}{2gJ} + H_2 + W_2 + Q_2 \qquad (9)$$

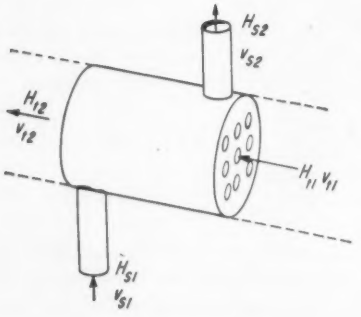
In addition to the simple schematic sketch of Fig. 2, we can visualize the energy flow by a scaled diagram as in Fig. 3. We can identify the various forms of the energy entering and leaving by this manner, but it's im-



5 Gas turbine develops mechanical work output from energy given up by fluid



6 Nozzle reorganizes motion in fluid to produce a jet with high leaving speed



7 Heat exchanger brings two fluids in close contact to transfer heat energy

practical to show just how much of each converts to the other forms inside of the device. But the total width of flow bands entering must be the same as the width of flow bands leaving. We have used this scheme in studying air compressors and internal-combustion engines, which are essentially nonflow machines, but it applies best of all to steady-flow machines. This helps us imagine rivers of energy with all their incoming and outgoing branches.

Now that we've shaken down this equation let's study some simple cases and learn how to use it.

Fan. To apply equation (9) we must be able to identify all forms of energy entering a device, such as a fan, and all the forms leaving. The air, Fig. 4, enters with a given enthalpy H_1 and velocity v_1, it leaves with enthalpy H_2 and velocity v_2. We need work input W_1 to turn the fan rotor, and, of course, it has no shaft work output. For most fans we have no heat transfer into or out of the fan, so we can write: energy entering = energy leaving, or:

$$\frac{wv_1^2}{2gJ} + H_1 + W_1 = \frac{wv_2^2}{2gJ} + H_2 \qquad (10)$$

We can then solve for:

$$W_1 = H_2 - H_1 + \frac{w}{2gJ}\,(v_2^2 - v_1^2) \qquad (11)$$

This gives us directly the amount of work input we need to run the fan to produce given enthalpy and kinetic energy changes. Sometimes the changes in kinetic energy are very small and can be ignored, then the energy equation reduces to simply $W_1 = H_2 - H_1$, a form we'll see quite frequently in the parts to follow.

Gas turbine. The gas turbine converts energy in the gas flow to shaft work, so again, using our basic premise: energy entering = energy leaving, or:

$$\frac{wv_1^2}{2gJ} + H_1 = \frac{wv_2^2}{2gJ} + H_2 + W_2 \qquad (12)$$

Then if we know the state of the gas entering and leaving, we can figure the amount of shaft work output:

$$W_2 = H_1 - H_2 + \frac{w}{2gJ}\,(v_1^2 - v_2^2) \qquad (13)$$

If the change in kinetic energy is small, as it usually is, the work output of the turbine is $W_2 = H_1 - H_2$. Compare this with the work input to the fan, above. Note how the subscripts arrange themselves to always give a positive answer for work input or work output.

Nozzle. Turbines use nozzles to direct a jet of working fluid over the blades and so convert some of the internal energy of the fluid into mechanical work. Let's study the energy balance around a nozzle. In Fig. 6 we see the entering high-pressure, P_1, fluid approach at a relatively low velocity v_1 and with an enthalpy of H_1. A jet of the working fluid leaves the nozzle in a region with lower pressure P_2; the jet has a high velocity v_2 and an enthalpy H_2. There is no heat transfer or mechanical work involved, so we can write:

$$\frac{wv_1^2}{2gJ} + H_1 = \frac{wv_2^2}{2gJ} + H_2 \qquad (14)$$

The kinetic energy of the jet is our point of interest so:

$$\frac{w}{2gJ}\,(v_2^2 - v_1^2) = H_1 - H_2 \qquad (15)$$

Often the entering velocity is negligible so we can consider v_1 equal to zero and for 1 lb per sec flow write:

$$v_2^2 = 2gJ(H_1 - H_2) \qquad (16)$$

This gives a direct method of calculating the velocity of the jet. No W and Q terms appear because there is no work or heat transfer.

Heat exchanger. In the shell-and-tube exchanger of Fig. 7 we have two fluids to consider. By the first law we can write for the shell fluid:

$$\frac{w_s v_{s1}^2}{2gJ} + H_{s1} = \frac{w_s v_{s2}^2}{2gJ} + H_{s2} + Q_{s2} \qquad (17)$$

assuming that the fluid is cooled in passing through the exchanger. Since the velocity change is negligible in all cases this simplifies to:

$$H_{s1} = H_{s2} + Q_{s2} \qquad (18)$$

and $$Q_{s2} = H_{s1} - H_{s2} \qquad (19)$$

We can write the same relations for the tube fluid, and since velocity changes are negligible and the fluid is heated:

$$H_{t1} + Q_{t1} = H_{t2} \qquad (20)$$

and $$Q_{t1} = H_{t2} - H_{t1} \qquad (21)$$

But the heat given up by the shell fluid is the heat acquired by the tube fluid so:

$$Q_{t1} = Q_{s2} \qquad (22)$$

and $$H_{t2} - H_{t1} = H_{s1} - H_{s2} \qquad (23)$$

Next part looks at how steady-flow fluids actually behave in certain cases —in a forthcoming issue.

How to beat the high cost of temperature control

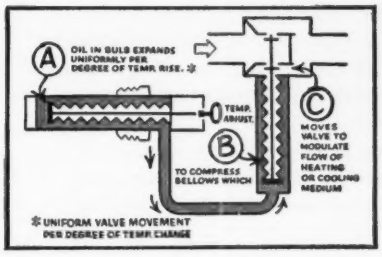
The practical approach to temperature control

By John W. Ritter, Test Engineer, SARCO Company, Inc.

Precise temperature regulation is essential in many processing operations, not only for quality control, but for maintenance of output as well.

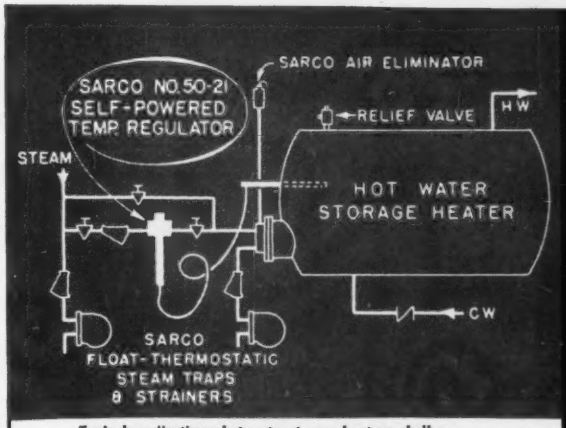
Manual temperature control is unsatisfactory because of the possibility of spoilage and loss of quality control which can result from irregular or indifferent hand regulation.

Automatic controls are available in a wide variety, including pneumatic, electronic, and self-powered. Pneumatic and electronic controls are relatively expensive to purchase and install, and may require frequent maintenance. However, in most applications, control requirements can be achieved very successfully by the use of relatively simple, economical Sarco Self-powered Regulators.


A
OIL IN BULB EXPANDS UNIFORMLY PER DEGREE OF TEMP. RISE. *
TEMP. ADJUST.
B
TO COMPRESS BELLOWS WHICH
C
MOVES VALVE TO MODULATE FLOW OF HEATING OR COOLING MEDIUM
* UNIFORM VALVE MOVEMENT PER DEGREE OF TEMP. CHANGE

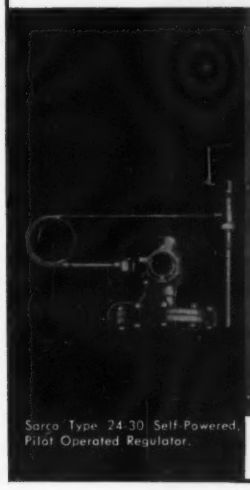
This drawing shows simplicity of operation of the Sarco 50-21 Temperature Regulator, which consists of a thermostat, capillary tubing, and a valve.

Sarco controls, like the 50-21 and the 24-30, have the required degree of sensitivity and dependability, combined with the ruggedness inherent in the sealed capillary tube construction. Because these Sarco controls do not depend on external power, such as electricity or compressed air, they have established long records of sustained, reliable operation. They are an economical and practical solution to the problem of maintaining continuous watchdog duty over processing temperatures.

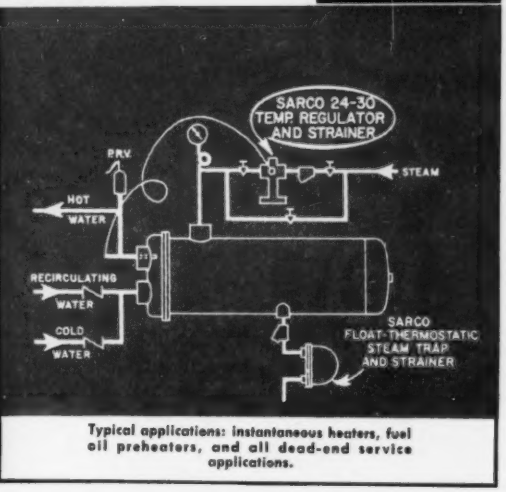


Typical applications: hot water storage heaters, shell and tube heat exchangers, condensers, oil storage tanks, dryers, kilns, etc.

Sarco Type 50-21 Self-Powered Regulator.



Sarco Type 24-30 Self-Powered, Pilot Operated Regulator.



Typical applications: instantaneous heaters, fuel oil preheaters, and all dead-end service applications.

Self-powered automatic temperature regulators by SARCO . . .

have these 5 marked advantages: No compressed air or electrical wiring required. No delicate mechanisms to adjust or maintain. No packing glands to stick or require maintenance. No shutdown during power failure. No specialized maintenance required.

Sarco Self-Powered Controls are self-contained and can be installed by any pipe fitter. They are so reasonable in cost that you can afford Sarco automatic heating controls for every application in your plant. Write for 10-page Sarco Control Bulletin No. 620.

6346-B

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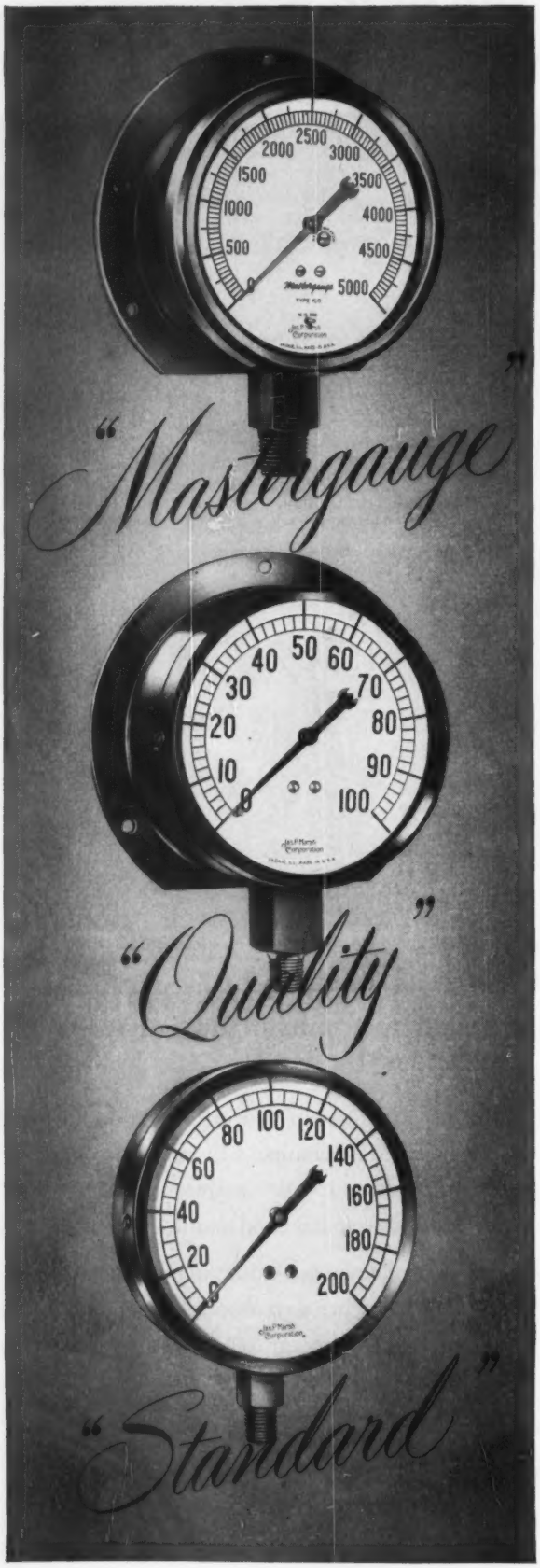
STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

For more facts circle 277 on Reader Service Card, p 100



What pressure gauge for your particular need?

The clear-cut economical answer to your specific gauge problem is right here in the Marsh line. It is here because the Marsh line contains the world's most complete range of gauges in the three broad brackets of gauge applications.

THE "MASTERGAUGE" GROUP...for those extreme services that demand the ultimate in gauge precision, accuracy and stamina.

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THE "STANDARD" GROUP...for the general run of pressure gauge services.

While these three brackets run a wide gamut of prices, the difference between them is not so much a matter of *grade* as a matter of *kind* and *purpose*. All gauges in all groups reflect Marsh precision and quality. Collectively they cover practically every conceivable gauge requirement.

The answer is in the catalog...but if you have a special problem let our engineering department work with you to select the most efficient, most economical solution to your problem.

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"THE STANDARD OF ACCURACY"

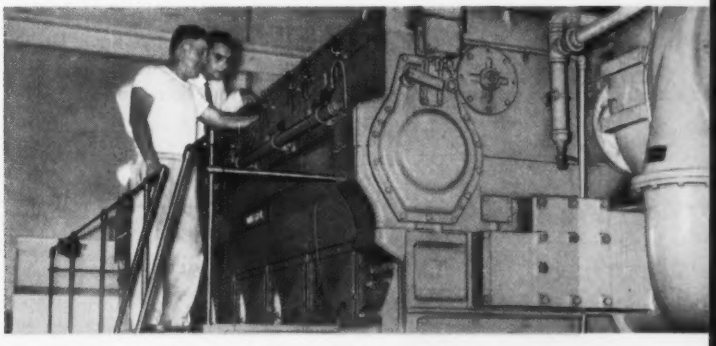
SLUDGE *situation gets a clean-up*

STANODIESEL Oil M helps keep diesels clean and running smoothly at Princeton, Missouri

The situation: Consumer Public Service Company, Princeton, Missouri, has three diesels in service—a 225 hp unit installed in 1951, a 1,083 hp unit installed in 1954 and a 1,440 hp unit installed in 1956. In previous equipment, sludging had been a problem, so when these units went into service, a heavy duty oil was recommended—STANODIESEL Oil M.

What has happened: The oil has been inspected regularly by a Standard Oil lubrication specialist. Samples are periodically removed for analysis at Standard's Whiting Indiana research laboratory. Analysis shows the oil to be in excellent condition. Since the 1,440 hp unit was started up in 1956, it has generated 1,672,200 kw hours of electricity.

What you can do: Find out more about how STANODIESEL Oil M can deliver service in your plant. Ask for more information from the Standard Oil lubrication specialist near you in any of the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



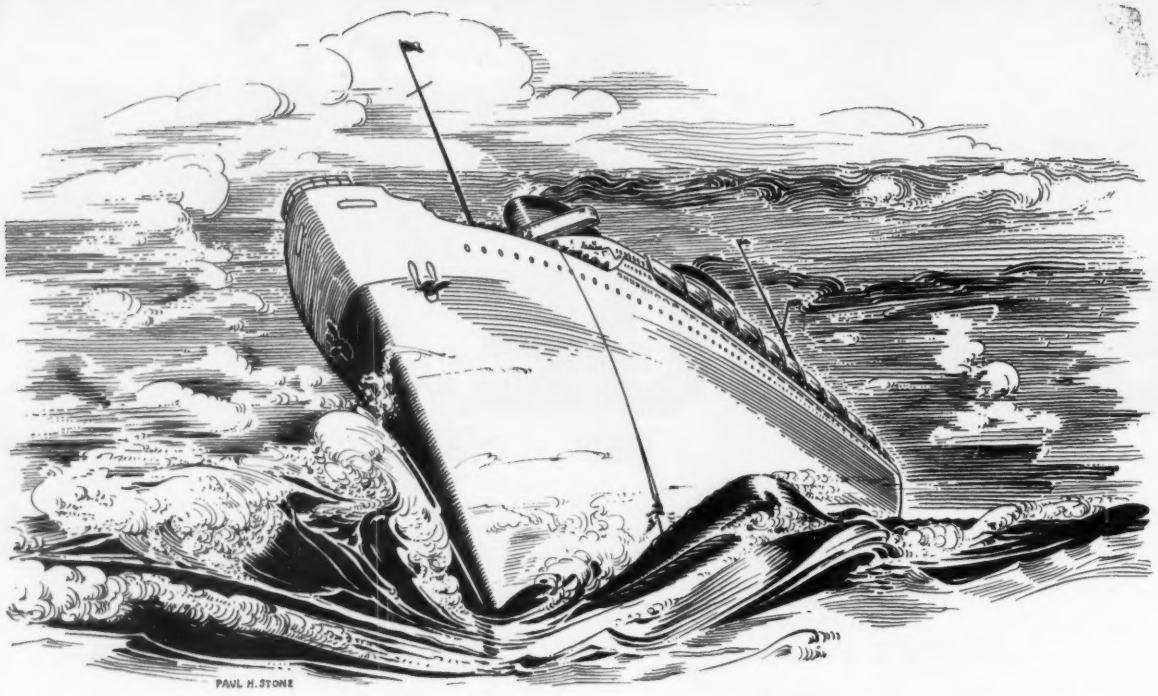
Darrel McCormick, Standard Oil lubrication specialist and William Rutledge, plant superintendent, inspect 1,440 hp diesel in Princeton, Missouri plant. Darrel is an experienced hand at this work. He has an engineering degree from Vanderbilt University plus four years' experience in industrial lubrication work at Standard Oil. He has also completed the Standard Oil Sales Engineering School.

Quick facts about
STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

You expect more from STANDARD *and you get it!*

For more facts circle 279 on Reader Service Card, p 100



"The *SS Rex* pitched and rolled as a sailor was put over the side to plug a dozen rivet holes," bellowed Marmaduke

Marmy's loose rivets

Watching the submarine *Nautilus* pull up the Hudson River from my 26th floor window put a few mental gears into motion. For one thing, I was suddenly back at sea again. And that brought into focus that old seadog, Marmaduke Surfaceblow.

I've seen a lot of expert seamanship, aboard both merchant and navy ships while sailing around this old globe. But navigating under the polar icecap called for something extra. "Boy," I said to myself, "I'll bet Marmy can't sound off on some experience to top that polar stunt." Still, I was sure he'd come up with something.

An hour later I was walking along the bustling west-side waterfront, heading for the Bent Propeller Bar —hangout for mariners, waterfront characters and local plant engineers.

Stepping inside, I could see Marmy's battered gray bowler above the crowd at the busy bar. Edging nearer, I ordered a short beer, then calmly sized up the situation before opening my mouth.

The foxy old consultant was preoccupied as usual, staring at a bottle of Sandpaper Gin before him. Paying no attention to the weather-beaten characters about him, he appeared to be wrestling with some big problem, like trying to harness the sun's energy.

"That *Nautilus* sailing under the polar icecap took some real seamanship, eh Mr Surfaceblow?" I ventured meekly, wondering if I should start shoving off. Nothing happened. But finally Marmy grabbed his bottle, worked up a vacuum of 16 inches on his cargo pump and ballasted his holds in one operation.

Slamming down his bottle, he roared in his foghorn voice:

"BILGEWATER on submarines. I'll tell you armchair engineers how I kept an ocean liner from popping her rivets and my only help was from her bartender."

That did it. A sea of bronzed faces turned toward our hero. Here was a pronouncement that must be listened to, one spoken by the voice of authority. Yes, *THE* voice of authority.

Marmy turned toward his expectant audience, gave

Turn page ▶

Marmaduke Surfaceblow . . .

is known to most of you as an ancient cantankerous consultant with a bumper crop of silvery seaweeds under his gray bowler. But he was a rough, tough guy back in his youth when he sailed the seven seas. To prove it, we dug up this portrait (dated 1914) in the office of a port engineer. Thought you Marmy fans would like to see it.

POSITIVE, TIGHT
VALVE CLOSURE...
under all variations of Temperatures and Pressures

* Simple indicator always shows amount of compensating spring compression.

New TYPE SA LimiTorque WITH COMPENSATING SPRINGS

Correct seating of the valve is extremely important during automatic valve operation, especially where fluctuation of high line temperatures are encountered.

To assure an absolutely tight seat, the new LimiTorque Type SA Unit incorporates unique compensatory springs which, literally, "take up" any amount of contraction or expansion caused by decreasing or rising line temperature.

These springs of Belleville Disc type vary in number for use in either parallel or series, within fixed limits, to provide the desired compensation. The result of continual improvement and development, the Type "SA" LimiTorque contains all the features of the famous Type SMA unit plus a simple indicator to show the amount of compensating spring compression. Available in Weatherproof and Explosion proof construction, these units can be mounted on any size valve in almost any position.

For information and data, write for Bulletin 4-57.

features:

- Controlled thrust applied to valve operating parts.
- Greater torque, thrust and stem capacity.
- Easier handwheel operation.
- Two piece stem nut design permits changing unit from one valve to another.
- Torque control for both directions of stem travel or single direction as required.
- Lubricant sealed in for life of unit.
- Simple indicator which always indicates amount of compensating spring compression.

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
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In one package you get complete instrumentation, automatic after-cooling and sample cooling, automatic timed pressure flush to maintain high recovery efficiency, individual volume control valves, (with illuminated sight flow indicators), heat exchanger and flash tank. Matching cabinet sink is final touch. All interconnecting piping and wiring are installed. Only service connections need be made.

Ready-to-install Packaged Console for Continuous Boiler Blowdown and Recovery Handles all Functions Automatically

Saves Engineering Time, Saves Installation Time; Gives Maximum Thermal Recovery. It Does Not Forget, Mis-time, "Overshoot" or "Undershoot"

Schaub's continuous boiler blowdown and sampling system helps produce significant boiler room savings. With each operation performed exactly as it should be, when it should be, with no water lost in overflushing or overcooling, reduced costs can be anticipated. Thermal recovery is constant and at a high level. Mantime requirements are less. Space requirements are reduced. This Schaub Automatic Console System needs only field service connections to put it into full operation. Several man-weeks of design time, plumbing, steam fitting and wiring are eliminated.

For those boiler rooms where the fully automatic operation, complete instrumentation and cabinet design of the Schaub Console system may not be desired, Schaub can provide a ready-to-install "basic" system which provides all the functions of continuous blowdown, but under manual control.

Two, three or four boilers can be handled; either 250 pound or 600 pounds WSP. Capacities to 6000 lbs./hr. total blowdown. To learn further details on Schaub Systems for continuous Boiler Blowdown, mail the coupon below.

Please send me, without cost or obligation, my personal copy of your Bulletin 8001 on Continuous Boiler Blowdown.

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Marmaduke

Continued from page 134

his bowler a starboard list, backed against the bar, then blasted away.

"Back in 1933 I landed in Genoa, Italy, aboard the steam yacht *SS Petras*. She was owned by a sharp New York playboy who never paid his bills. He was so much in debt that the local gendarmes slapped a lien against the *Petras* as soon as we tied up.

'After we'd been on the beach for two weeks, the American consul had us placed aboard the liner *SS Rex* as second-class passengers. She was sailing on her maiden voyage to New York.

"The *Rex* was the pride and joy of Mussolini and all Fascist Italy. Her 51,000 gross tons made her the largest ship ever built in Italy. Departure date was proclaimed a national holiday and she sailed with a full list of passengers.

"Her skipper was out to cop the blue ribbon for the Atlantic crossing from Gibraltar to New York. But two days out we hit heavy weather and the *Rex* began rolling like a drunken sailor. Then the proud maiden popped a dozen rivets in her hull plates amidships, about 10 ft below her waterline.

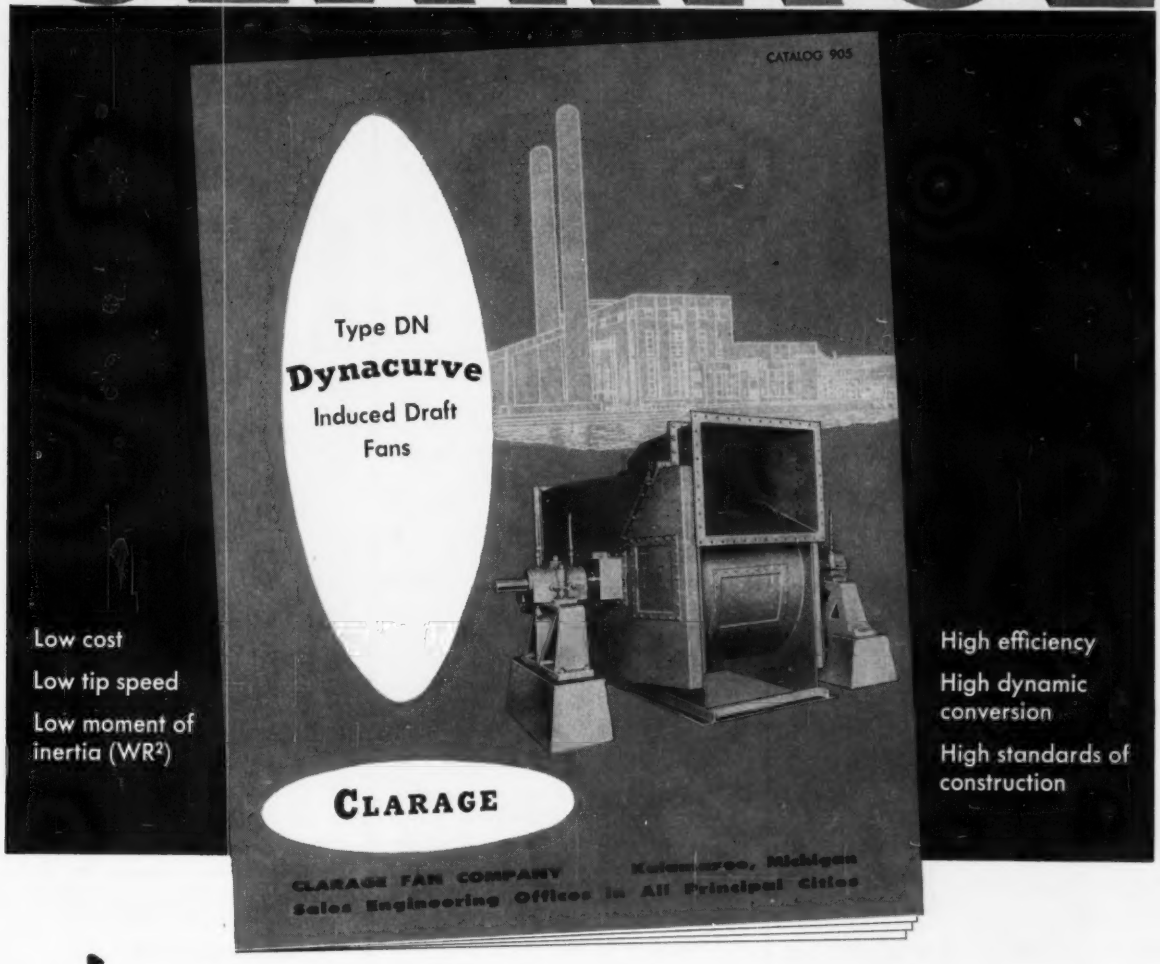
"The exposed rivet holes were in the boiler room. Some passengers got panicky, but the captain assured everyone there wasn't any danger as the holes would be plugged.

"I was interested in knowing exactly how the *Rex's* chief engineer would do the job. I soon learned he'd had hardwood tapered plugs driven into the holes. But the strain on the plates that had popped the rivets in the first place loosened the wooden plugs in a hurry, and other rivets in the area were starting to loosen.

"Next morning word got around that the chief had asked the captain to put a sailor over the side in a bosun's chair. This seaman was to push a bolt through each hole from the outside while the engineers in the fireroom slipped a gasket, washer and bolt over the threads and tightened each bolt.

"That scuttlebutt was right because next morning there was plenty of excitement aboard. Up on deck the mate was having a bosun's chair rigged. It had a line running down

CLARAGE



Learn more about the stand-out fan in the induced draft field

Request Catalog 905 or contact the nearest Clarage sales engineering office.

Dependable equipment for making air your servant

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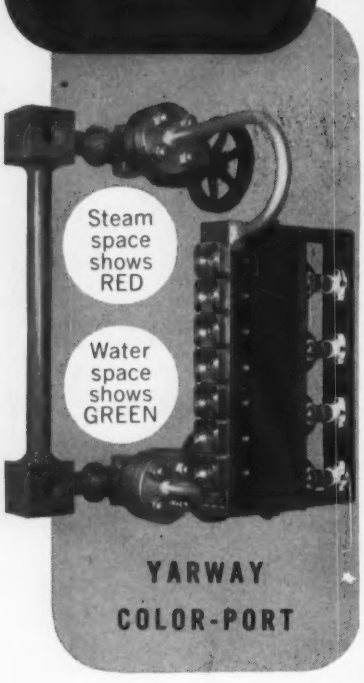


This newest Yarway boiler water gage for pressures to 3000 psi features maintenance as easy as A-B-C—plus **brilliant** red and green water level readings. Write for Bulletin WG-1814. YARNALL-WARING CO., 100 Mermaid Ave., Philadelphia 18, Pa.

Branches in all principal cities.

go YARWAY *with confidence*

Marmaduke

Continued from page 136

under the keel and up the port side to keep the sailor from smacking against the hull each time the *Rex* rolled. And she was rolling plenty.

"As passengers swarmed all over the deck to watch, several seamen stepped forward and volunteered to do the job. With the ocean kicking up her heels, it took a brave man to go over the side, no mistake about it. When the first seaman was lashed into the bosun's chair, the captain changed the ship's course to put him on the lee side.

"But still the *Rex* rolled, bringing the rivet holes out of the water one minute, then plunging them 20 ft under water the next minute. The sailor rolled under the waves as he tried bravely to insert the bolt before getting waterlogged himself.

"By the time the first bolt was inserted he was half drowned. Talk about keel-hauling practiced in sailing-ship days, this was the nearest thing to it that I've seen. It took a sailor with guts, and that sailor was a hero to everyone aboard. But I felt sorry for him because I knew there must be a simpler way to do the job.

"With hundreds of passengers on deck yelling 'Bravo' as they hauled the sailor aboard, the second volunteer came forward with a do-or-die expression on his face. But I elbowed up to the chief officer who was running the show.

" 'Don't send any more men over the side,' I advised the mate. 'I'll get those bolts into the rivet holes from inside the ship. And I'll do it quicker and no one will get drowned.'

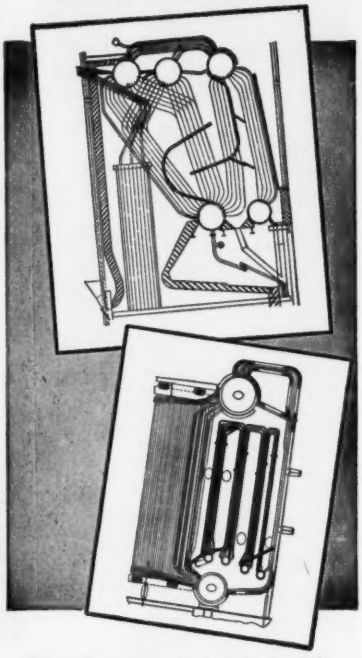
" 'Bravo,' yelled the passengers near enough to hear me.

"When the noise quieted down, the mate wanted to know how I'd do the job. I told him I'd need the bartender's help.

" 'Bartender,' he yelled, then he started getting pink around the gills.

" 'Look, I'm not joking,' I told him. Just then the captain came down from the bridge to see what was holding things up. I explained to him and the mate that I'd plug those holes from the inside. But the bartender would have to bring a dozen bottles of Sandpaper Gin to my cabin. To show the captain I wasn't

ONLY
ENCO
BAFFLES
give you all these
COST CUTTING
FEATURES



These important fuel-saving maintenance-reducing features are obtainable with Enco boiler baffles—*and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottlenecks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

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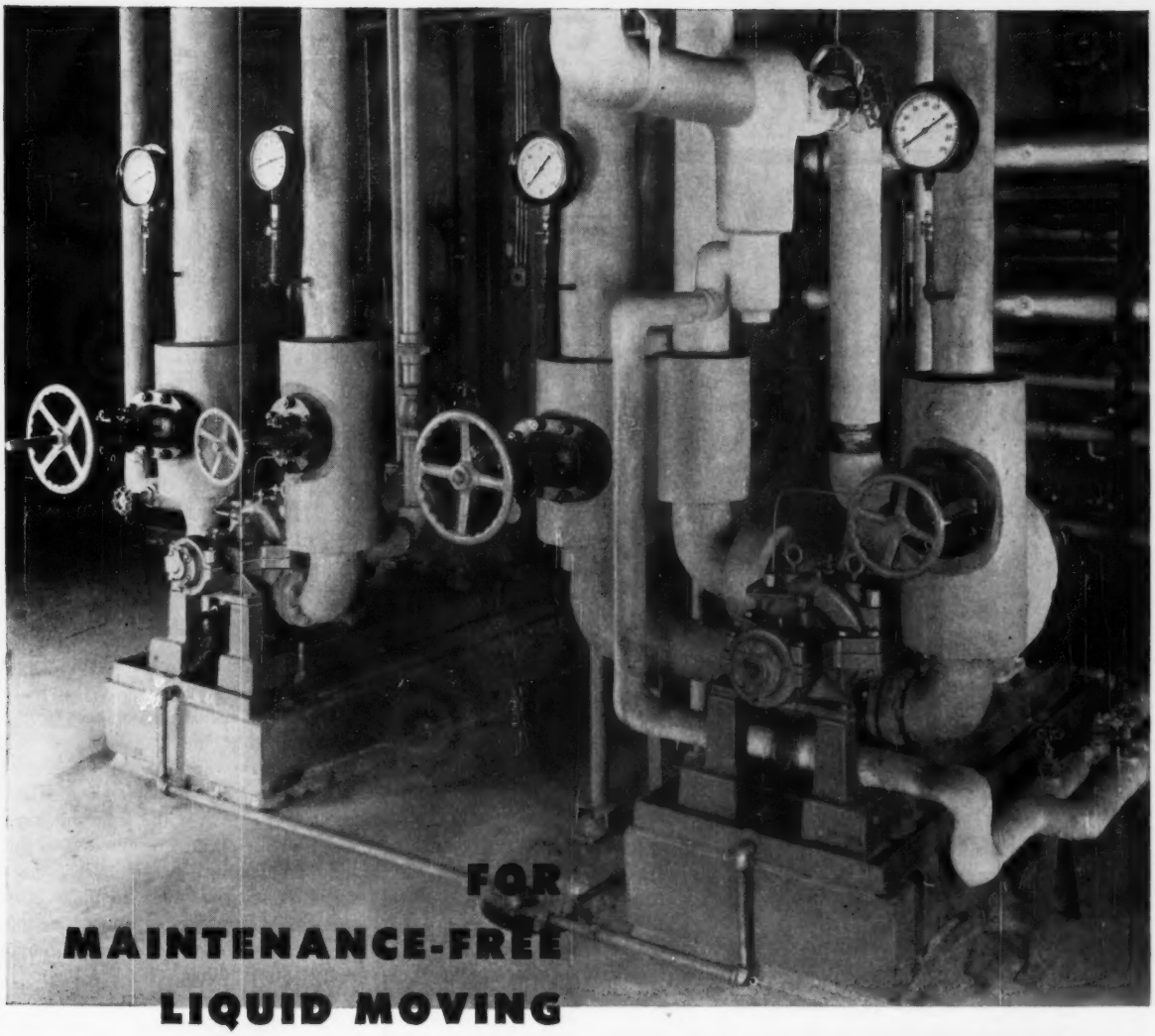
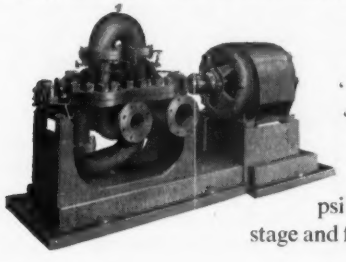


FOR MAINTENANCE-FREE LIQUID MOVING

"Buffalo" Class "RR" Pumps

For boiler feed and other high pressure, high temperature applications with clear water, "RR" Pumps deliver the utmost performance with an absolute minimum of maintenance. The unique "Buffalo" Class "RR" design is unsurpassed for consistent hydraulic balance. Rugged "Buffalo" construction features include efficient impellers — extra generous bearings and shafts — rigid casings with simply-formed passages to avoid friction losses — very deep stuffing boxes to accommodate more packing.



"Buffalo" Type "RR" Boiler Feed Pumps for pressures up to 500 psi. Available in two-stage and four-stage models.

These superior "Buffalo" design and construction features assure you of pumps that will stand up under continuous punishing service — that require practically no attention other than lubrication — that deliver more water at less cost for power.

The "Buffalo" Class "RR" Pump is your best buy for clear water service — hot or cold — against heads as high as 1500 feet — at capacities up to 900 gpm. Ask your nearby "Buffalo" engineering representative for full information, or write us for Bulletin 980-D.

"Buffalo" Pumps bring you the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.

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A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

REDUCE HEATING COSTS! CLEAN BOILERS WITH A

TORNADO® JUMBO
VACUUM CLEANER

★ 55 GA. CLEANING CAPACITY ON ANY STANDARD DRUM.

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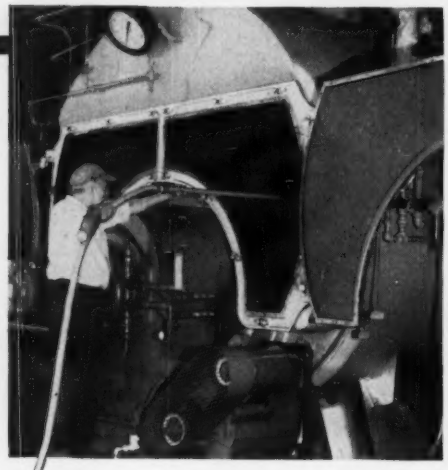

USE YOUR OWN STANDARD 55 GAL. DRUM.

Dirty, soot-clogged boiler tubes can easily double fuel bills.

To call in an outside service to clean your boiler is expensive.

Why not solve boiler problems with a Tornado Jumbo vacuum cleaner. It's actually a powerful motor unit with a cover and filter bag that fits right on any standard 55 gallon drum. (4 Wheel dolly also available.)

We'll supply the proper hose and tools so that this cleaning job will take but a few minutes, and all the soot is right there in the drum to be carried away. Most users save the full cost of their Tornado Jumbo in a few months, by reduced fuel bills.

What's more you get an extra bonus in the way the Jumbo does numerous other important cleaning jobs too!

Start your fuel savings now!

Write for Jumbo Bulletin No. 899

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Gentlemen:
We would like to reduce our heating costs with improved boiler cleaning. Please have your distributor contact us for a demonstration.

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Marmaduke

Continued from page 138

fooling, I asked him to send the chief engineer up so I could outline my plan.

"The skipper wanted the job done without losing that blue ribbon. So he said, 'Will do.' Soon as the chief, the bartender with his twelve bottles and the mate were in my room, I gave them my instructions. After pulling all the corks, I gave them to the chief and told him to fasten a fishline to each one. Then I told him to stick one cork at a time through a rivet hole from inside the fireroom.

"'You'll have to slow the ship down and fish the cork out of the water with a long hook,' I told the mate. 'Maybe you can make one from a long piece of heavy wire or tubing.'

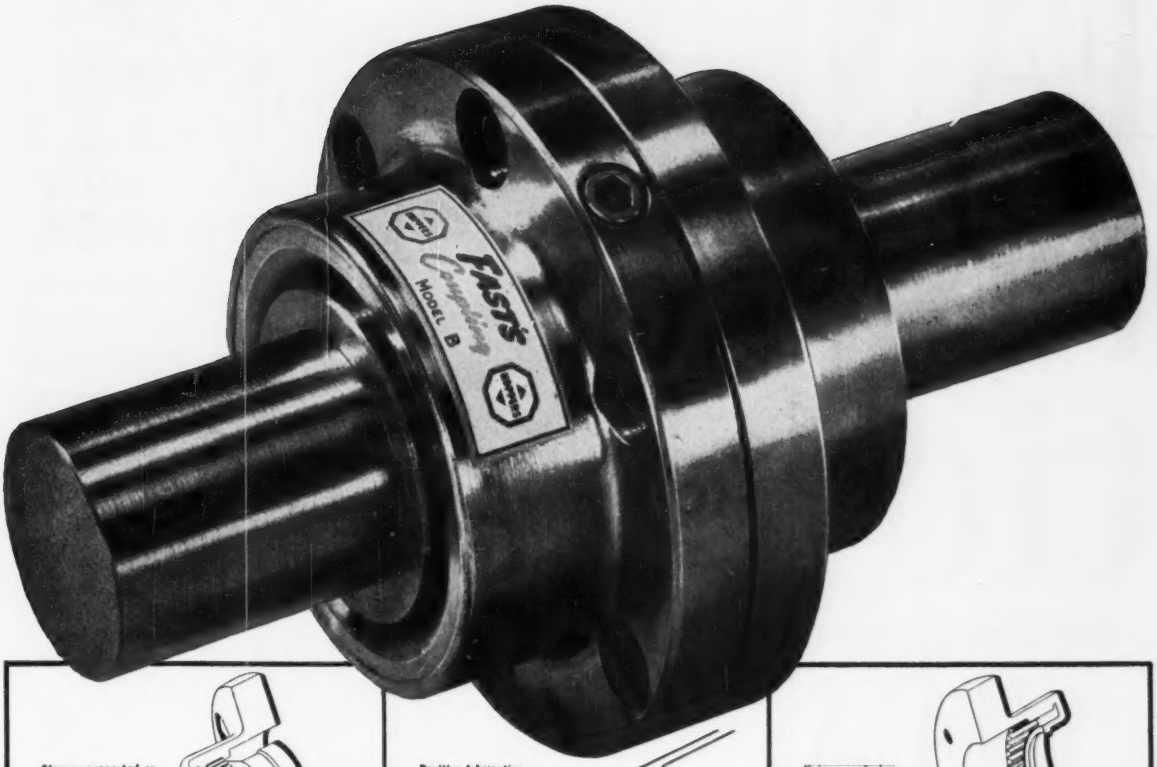
"'As for you,' I told the chief, 'Have your machinist drill and tap the threaded end of each bolt for a tiny eye-bolt. Then when the mate has a cork fished out of the water from topside, he can remove the cork and tie the line onto the eye-bolt screwed into the bolt's end. Then heave the bolt over the side and have one of your engineers put it into the hole from down below in the fireroom. Once the bolt's in place, slip the gasket and washer over the bolt as you did before. Tighten it and your job is done.'

"They all agreed that was a good idea. While I rounded up my shipmates from the yacht to do justice to the twelve bottles of Sandpaper Gin, my plans were carried out on deck and below. Inside of three hours all the bolts were tightened in place and the *Rex* was brought up to top speed again.

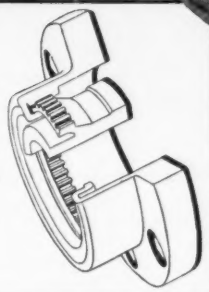
"When the job was finished I became the new hero. For the rest of the voyage I couldn't spend a cent. Everyone was treating me . . . and I even sat at the captain's table.

"The *Rex* did win the blue ribbon for her crossing, making the trip in 4 days, 13 hours and 50 minutes. And all I had done was come up with what's known today as the Marmaduke *Theory of Buoyancy*. It goes like this:

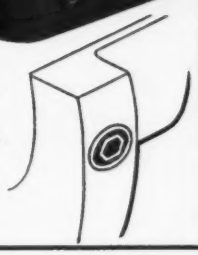
"If you push a cork into a bottle, the cork'll float and maybe act like a check valve when you turn bottom's up. But that won't stop a seaman from getting lubricated if he's got his mind made up." continued



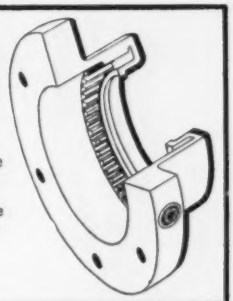
Sleeves supported on hubs. Metal end ring is dust and moisture-resistant and wear-proof. No perishable, non-metallic element is involved.



Positive lubrication— Fast's design assures continuous film of lubricant on load-carrying surfaces. Lubricant is protected from pollution by exclusive end ring design. Lube plugs in sleeve flanges afford convenient access.



Unique centering of sleeves— No crank action or vibration is possible because end rings are positively positioned on transverse center line of hub spline faces.



Fast's Model B coupling reduces downtime and upkeep for light-to-medium drives

Mechanical flexibility eliminates costly shutdowns and expensive shaft replacements. But—it's only one of many cost-saving features.

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 3301 Scott Street, Baltimore 3, Md.

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FAST'S Couplings

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increase cooling tower efficiency with MORE CFM and LESS HP

Precision engineered Aeromaster Fans with variable pitch blades and anti-flutter design give cooling at *lower cost.* Blades resist acids, alkalies, abrasion and weather. 4, 6 or 8 blade styles in 54″ to 22′ diameters. Before you replace or consider new equipment, write: KOPPERS COMPANY, INC., 2601 Scott Street, Baltimore 3, Md.

KOPPERS Aeromaster Fans

Engineered Products Sold with *Service*

Marmaduke

Continued from page 140

Having uttered this most unusual "theory," the most unusual Marmaduke Surfaceblow turned back to his bottle. I walked out of the place as if in a trance. My head felt light because my mental gears had slipped a few cogs after listening to Marmy.

—STEVE ELONKA

Marmy's Mailbox

'Tis here you exchange blasts with the old boy

PULLS A MARMY

A while ago I was called to check a cargo winch on a freighter. It was a dc job, 150 volts with spring-set electrically operated brake. The ship's crew had been tinkering with it since the day before, but without success.

I noticed at once that the brake didn't open electrically when motor started. I checked the chief's drawings. Then, tracing the coil wires I found the return broken. So I made a quick connection, checked all connections and put the parts together. Inside half-an-hour the winch was working. Solving that problem saved the ship a day in port, or about $1000. Keep those Marmaduke stories coming.

J H ACEVEDO, *Mayaguex, P.R.*

KAISER FANS

We at Kaiser Aluminum enjoy reading Marmy's experiences.

R E LOWRY, *Chicago, Ill.*

BG FANS

We at Bell & Gossett enjoy reading about Marmy's experiences. His book is a most welcome addition to my personal engineering library.

G MILLER, *Chicago, Ill.*

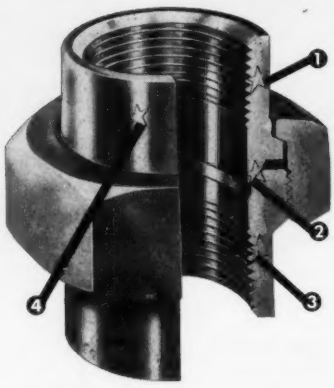
WONDERS

I enjoy every one of the Marmy stories and envy the author, his background and imagination. I always wonder what will come next.

E A ROBERTS, *Carlsbad, N. M.*

only CATAWISSA

gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 58 showing the complete Catawissa line of Perfect Seal Products.

for complete, guaranteed satisfaction

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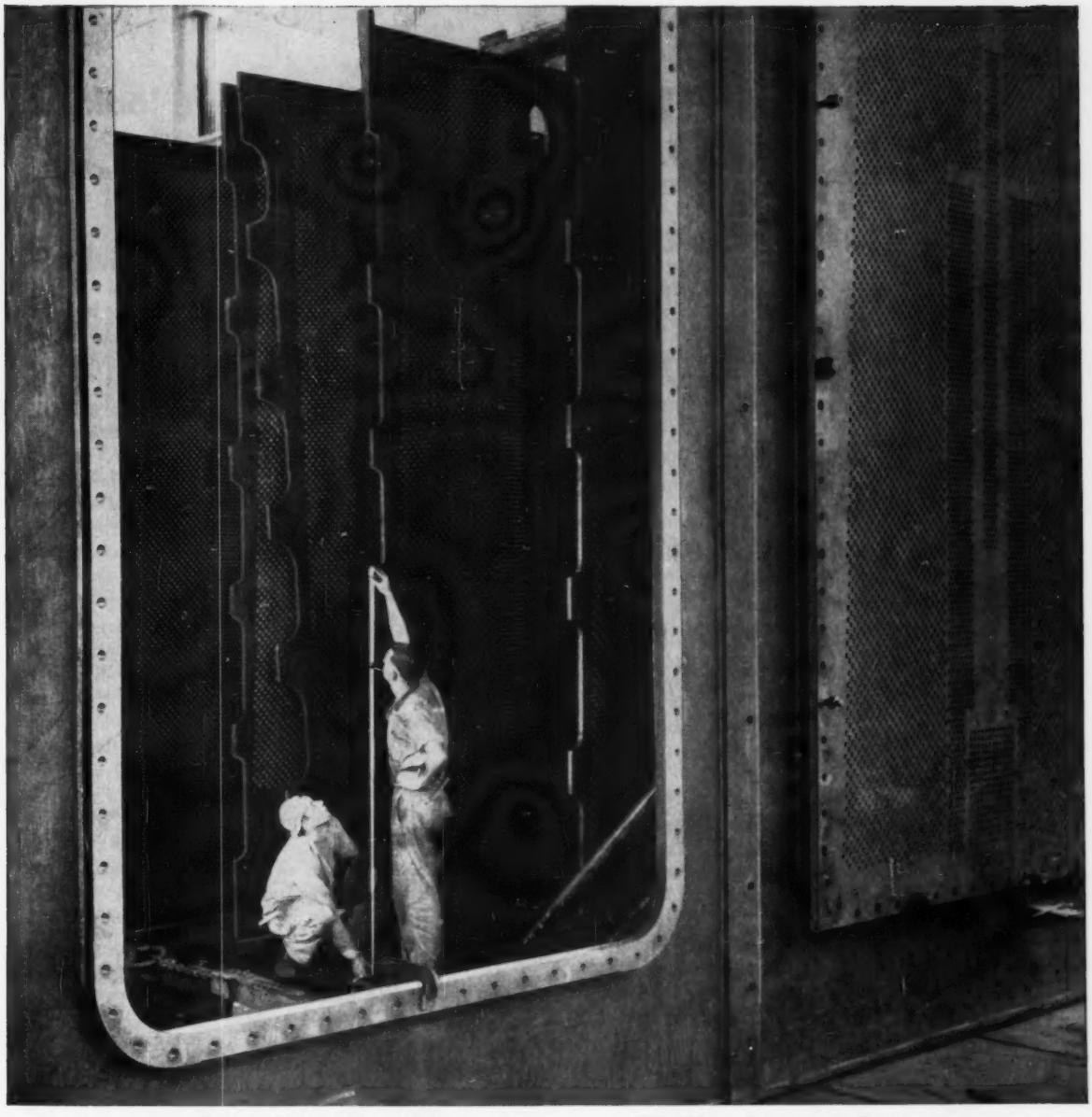

Twin-shell, triple-lane, single-pass Condenser with 187,000 sq. ft. capacity. One of largest units ever built, it was recently installed at large eastern utility.

In tube layout, too... design makes the difference with C. H. Wheeler condensers

You see here one of the many reasons why C. H. Wheeler Dual Bank Surface Condensers operate so efficiently in scores of public utilities and industrial plants throughout the country.

Triple Lane Tube Layout, with three separate pathways for steam travel, allows the steam to penetrate to the peripheries of all tubes.*

Design like this, typical of C. H. Wheeler engineering, steps up condenser efficiency. Other engineering advancements—such as patented Reverse Flow, which permits flushing away leaves, twigs, algae and other foreign matter—reduce maintenance requirements. "Zero" condensate temperature depression, pure condensate and deaeration to 0.03 cc. of oxygen per liter (special design provides for deaeration to 0.01 cc. of oxygen per liter) . . . are additional features you get with C. H. Wheeler Condensers.

**Location of the air-vapor take-off reduces the resistance to steam passage. This minimizes the depth of steam penetration through the tube bank of all C. H. Wheeler Condensers.*

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Powerscope . . . A selective look at

Focusing the 'scope on the U.S.S.R.

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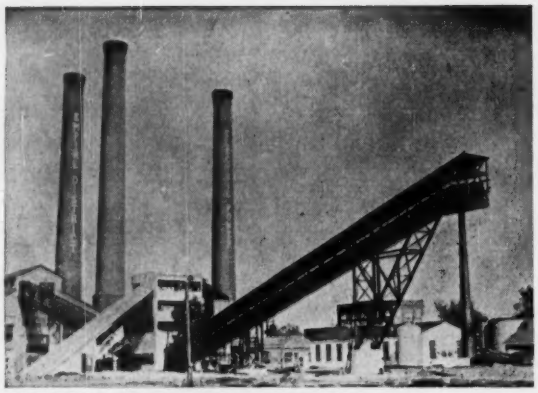
EARN EXTRA PROFITS IN SAVINGS



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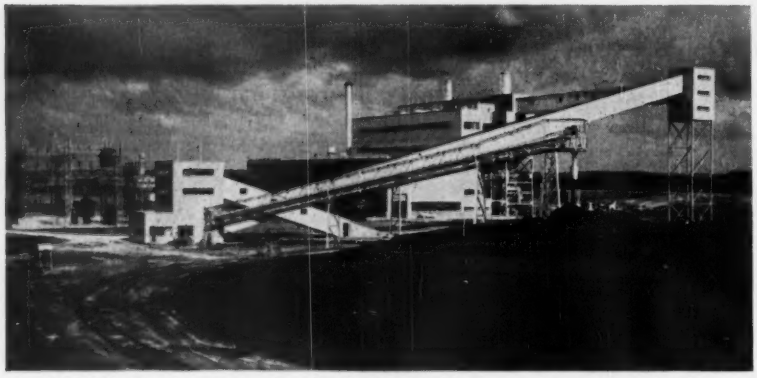

McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

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Are you paying "extra fare" luxury rates for that last ride your coal must take from the truck, car, or barge, to your bunkers?

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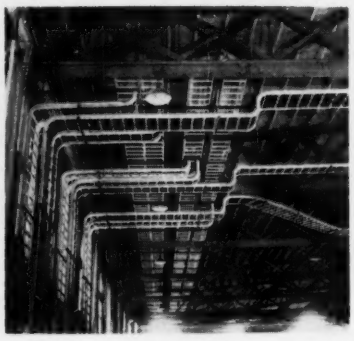
City and State_____

Reports from the field



Convention-hall cables are laid on ladders

Power system for Philadelphia's Convention Hall had to be efficient, flexible, easily maintained—and installable between nearly continuous shows. The Hall's power is provided by three 1000-kva transformers with a total of 30 circuits.

Engineers decided to use neoprene power cables laid on galvanized-steel cable ladder made by T J Cope Div of Rome Cable Corp. This is economical, and easily maintained because cables are visible through "rungs" of the ladder. Cables can be dropped out between rungs for rerouting; new cables pulled in as needed.

Milled-peat electricity keeps Irish lamps lighted

Peat has always been a staple fuel of Ireland. Chunk-style sod peat has fed Irish fires since time immemorial, and currently accounts for 30% of the nation's electricity. Now a 240-million-kwhr per year station has gone into operation, designed to burn 500,000 tons annually of *milled* peat.

The station is located at Ferbane Co., Offaly, Ireland. In Bord na Mona (Peat Development Board) bogs in the neighborhood, milled peat, a semi-carbonized vegetable tissue formed by partly decomposed moss, is scraped up in successive harvests. Five-ton lots of peat are delivered to the station by a light railway, then fed by belt conveyors to bunkers or nearby stockpiles. En route, fuel is automatically weighed and sampled.

At this stage, moisture content is high. Fuel has to be dried with hot

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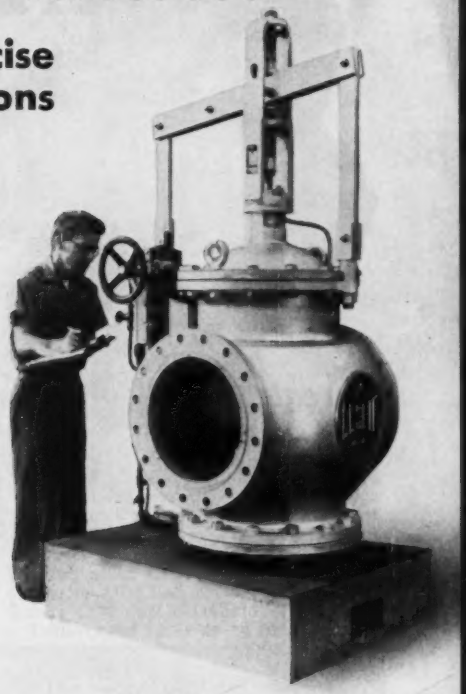
A complete line for precise power applications



Leslie Co. offers a wide range of single seated valves in sizes ½" to 16" and double seated control valves. In addition, there are many new standard valves designed specifically for power industry applications in both sub-critical and super-critical power generating stations. Valves are available with these power service features:

- **Exclusive Leslie seat protections eliminate erosion problems in high-pressure drop throttling services.**
- **New Leslie "cage" construction permits replacement of inner valves, seats and guides without removing valve body from the line. Down-time for replacement or inspection is cut to a minimum less than 20 minutes.**
- **Control valves in extremely severe high-pressure drop service have infinite rangeability.**
- **Stellite faced and solid stellite inner valves and seating surfaces for maximum erosion resistance.**

Leslie control valves are designed to handle hot and flashing condensate . . . temperatures to 1150°F per ASA rating. They are providing reliable service under extremely severe operating conditions in a variety of central station applications such as:

- **Condensate drains from feedwater heaters**
- **Boiler feed pump recirculation**
- **Desuperheater spray water control**
- **Turbine lead drain remote manual start-up control**

You may choose from a variety of sizes and diaphragm actuators to accommodate almost any operating air supply up to 100 psi. In addition, electro-mechanical, pneumatic cylinder and electro-hydraulic actuators can be supplied.

For specific engineering data, write today for data sheets illustrating the cage trim construction and other Leslie features.

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REGULATORS and CONTROLLERS

LESLIE CO., 235 Grant Avenue, Lyndhurst, New Jersey

GUARANTEED

to give drip-tight leak-proof seal

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greatest name in unions **DART**

For over 55 years the firm guarantee back of each and every DART UNION sold has been — *"if one should leak through we will give you two"!* The record reveals that less than 1 in every 100,000 has proven to be faulty. The extra wide bronze to bronze seats, precision ground to a true ball joint, mounted in heavy malleable iron pipe ends and protected by an extra heavy union nut, make a drip-tight, leak-proof connection WITHOUT EXCESSIVE WRENCHING time and time again.

Guarantee positive tight connections and extra long service on your pipe lines by using the DART GUARANTEED UNION.

Yours on request: Descriptive brochure on Dart Unions and Union Fittings.

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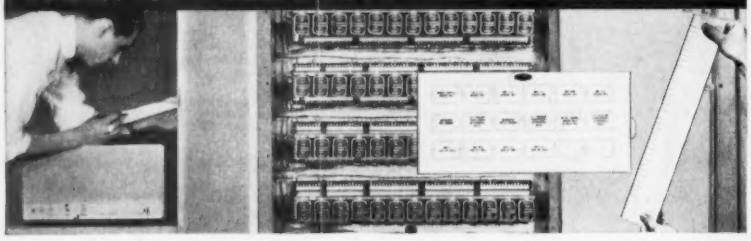
RECORDS POWER SHUTDOWNS, HELPS PREVENT RECURRENCE



New PANALARM Recording Annunciator Uncovers Profit Leaks

- **Pinpoints power station trouble spots by accurately, instantly recording off-normal and on-off operations.**
- **Permanent, unalterable statistical data helps prevent stoppage repetition.**
- **No time-wasting decoding. Directly readable digital form.**

TYPICAL APPLICATION:

The exact time period of steam stop valve closure, generator circuit breakers and overspeed trip resets is permanently recorded, providing advance notice of sluggish functioning and permitting immediate preventative action.

Earnings from lost electrical sales are gone forever. Model RA helps lessen such losses by reducing downtime, maintenance and operating costs. Write for Bulletin 102 today.

PANALARM

PANELLIT, INC.
7401 No. Hamlin Ave., Skokie, Ill.

For more facts circle 294 on Reader Service Card, p 100

Reports from the field

Begins on page 146

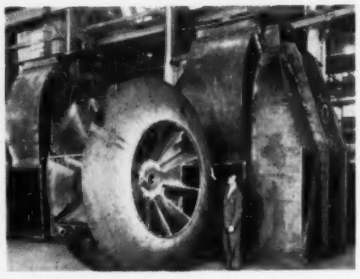
gases in special mills, where it is also pulverized. Then the peat is blown into combustion chambers of three boilers, each of which can produce 220,000 lb per hr of steam. The steam drives three 25,000-kw steam turbo-alternator sets.

Power is produced at 10,500 v, raised to 110,000 v at an outdoor transformer station, then fed into the national transmission grid.

Milled-peat burning is not an Irish "first". World's premiere for milled-peat power took place in Russia. The Irish Electricity Supply Board, however, plans two more milled-peat stations for Eire.

Station's three sets need 80,000,000 gal of water daily to operate the condenser. Two cooling towers 266 ft high and 186 ft in diameter cool 99% of the water; the remaining 1% is made up from the adjoining Silver River.

The station is Irish-designed, and built of exclusively Irish-fabricated steel. It was completed in 1957.



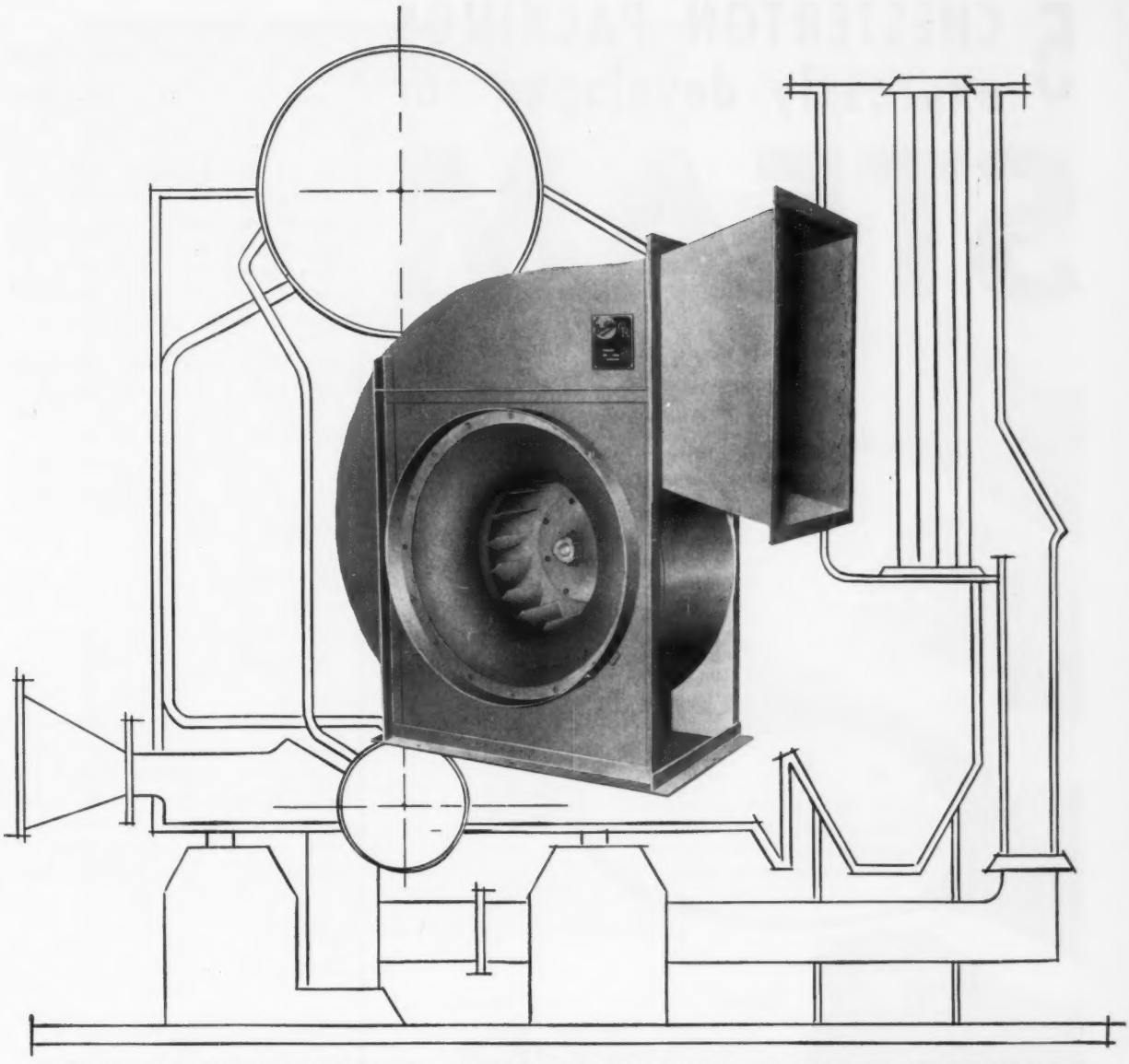
Gas recirculating fans handle 251,111 cfm

Believed to be the largest fans yet used for this service, units are designed to recirculate gas at 715 F. Once installed at Detroit Edison Co's St. Claire Station, they will serve a 2,100,000-lb-per-hr boiler.

Housings weigh 13 tons, wheels 6 tons. Units were built by American Blower Div of American Standard.

Calendar of Events

Jan 26-29—Tenth Plant Maintenance & Engineering Show and Conference. Public Auditorium, Cleveland, Ohio. Details from Clapp



FOR ECONOMICAL MECHANICAL DRAFT SERVICE

"BUFFALO" TYPE "CR" RADIAL WHEEL DRAFT FANS

Combining sharply rising pressure and horsepower characteristics with high static efficiency and resistance to abrasive effects, the "CR" is an ideal fan for stoker-fired or pulverized coal boilers. It is also proving an excellent choice for handling air with dust loadings in a wide range of industrial jobs. Too, these same high-pressure, high-capacity characteristics may mean a smaller fan for many direct-connected applications — a saving in first cost.

Write for Bulletin FD 205 and see the dependable, stable performance built into this husky radial wheel fan for constant volume or inlet-dampered operation. It's one of a *series* of specialized "Buffalo" Draft Fans — including airfoil and backward curve designs with a wide choice of wheels — to give you the best service your operation requires.

NOTE: *Every "Buffalo" Fan has the exclusive "Q" Factor—the built-in Quality which provides trouble-free satisfaction and long life.*

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BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

For more facts circle 295 on Reader Service Card, p 100

5 CHESTERTON PACKINGS expressly developed for STEAM

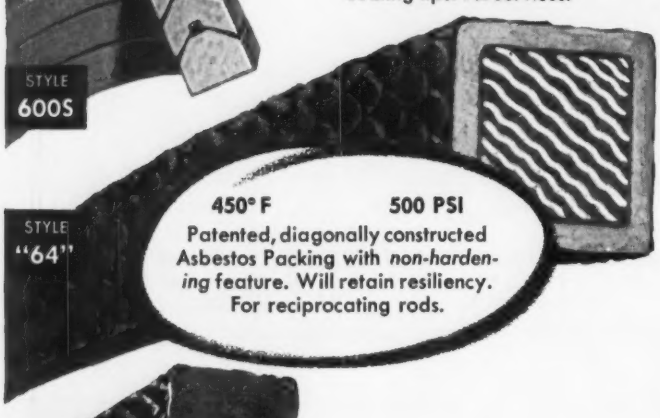
HEAT . . . . . PRESSURE

1000°F 2000 PSI

A 95% pure asbestos braided yarn with monel wire insertion. Mica lubricated. For extreme heat and pressure service.

550°F 1000 PSI

Improved self-sealing moulded Asbestos Packing with multiple feather sealing lips. All services.



450° F 500 PSI

Patented, diagonally constructed Asbestos Packing with *non-hardening* feature. Will retain resiliency. For reciprocating rods.

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Soft, highly lubricated Asbestos Packing for medium to low pressure and fast moving shafts.

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Compressed Asbestos Sheet. Homogeneously constructed with complete graphite impregnation. Cuts easily. *"Lasts as long as the iron."*

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Reports from the field

Begins on page 146

& Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Jan 26-30—American Society of Heating and Air-Conditioning Engineers, Inc, Annual Meeting and Exposition. Convention Hall, Philadelphia, Pa. Details from International Exposition Co, 480 Lexington Ave, New York 17, N. Y.

Jan 28-29—Armour Research Foundation of Illinois Institute of Technology and **American Welding Society,** Midwest Welding Conference. Illinois Tech campus, Chicago. Details: Harry Schwartzbart, Armour Research Foundation, 10 W 35th St, Chicago 16, Ill.

Jan 29-30—University of Wisconsin, Engineering Institute on Industrial Power-System Requirements. Details: Robert Loetscher, U of Wisconsin, Madison 6, Wis.

Feb 8-14—National Electrical Week. Purpose: To enhance public appreciation of electricity and the contributions of the electrical industry to the nation's progress and economy. Details from National Electrical Week Committee, 290 Madison Ave, New York 17, N. Y.

Mar 8-11—American Society of Mechanical Engineers, Gas Turbine Div, Gas Turbine Conference. Cincinnati, Ohio. Details: ASME, 29 W 39th St, New York 18, N. Y.

Mar 16-20—National Association of Corrosion Engineers, Annual Conference and Corrosion Show. Chicago, Ill. Details from NACE, 1061 M&M Bldg, Houston 2, Texas.

Mar 16-20—American Society for Metals, Western Metal Exposition and Congress. Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles. Details from Jack Straton, 215 S Clark Drive, Beverly Hills, Calif.

Mar 31-Apr 2—Illinois Institute of Technology, American Power Conference. Hotel Sherman, Chicago. Details: R A Budenholzer, Illinois Tech, 3300 Federal St, Chicago 16, Ill.

50,000 kilowatt central station built for Southwestern Public Service Company.

Solving the paradox of power plant construction through Pritchard's GOOD FINANCIAL DESIGN

How much should you invest in power facilities? This question has a double-edged answer. If you aim for lowest plant cost, the result can be poor efficiency and high operating costs. On the other hand, building for the best heat rate can run costs so high that the completed plant may not earn a reasonable return on invested capital.

Building power plants that offer the best solution to this kind of problem is a Pritchard specialty. All of Pritchard's services—ranging from economic studies, engineering and construction, to delivery of a turn-key plant—are focused on good financial design that balances operating costs against capital investment. Examples of Pritchard's skill in striking this economic "balance" point can be found in many power installations over the country.

When you are confronted with the paradox of power plant construction, let Pritchard help you get the most advantageous solution. Pritchard is staffed to submit a turn-key proposal – or can supply design, engineering or construction services separately.

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BELMONT

Reports from the field

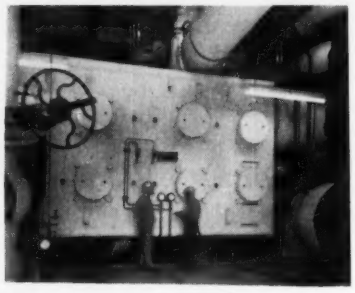
Begins on page 146

Power's history

POWER was founded in 1884 by E P Harris and H M Swetland. With it was incorporated *Steam* which had been started by N Hawkins in Chicago two years earlier.

In 1903 POWER purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trade's Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine.*

In 1908 POWER absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power* and *Machinery Magazine, The Stationary Engineer, Steam Engineering and The Mechanical Engineer.* When *The Engineer* was purchased, the name of the combined magazine was *Power and the Engineer.* The title was condensed to POWER in 1911. In 1951, POWER absorbed *Operating Engineer.* All rights to above titles reserved.



Size record is broken by condensing unit

Breaking a size record set in the '20's, world's largest operating condensing unit recently went into commercial operation as Unit No. 7 of the Commonwealth Edison Co's Waukegan, Ill. generating station.

Unit has 180,000 sq ft, serves a 325-mw turbine-generator. It is made up of two 90,000-sq-ft single-pass condensers, and has aluminum tubes instead of copper alloy ones. Previous record holder was a 176,000-sq ft condenser, made up of a set of eight 22,000-sq-ft units.

For more facts circle 298 on Reader Service Card, p 100

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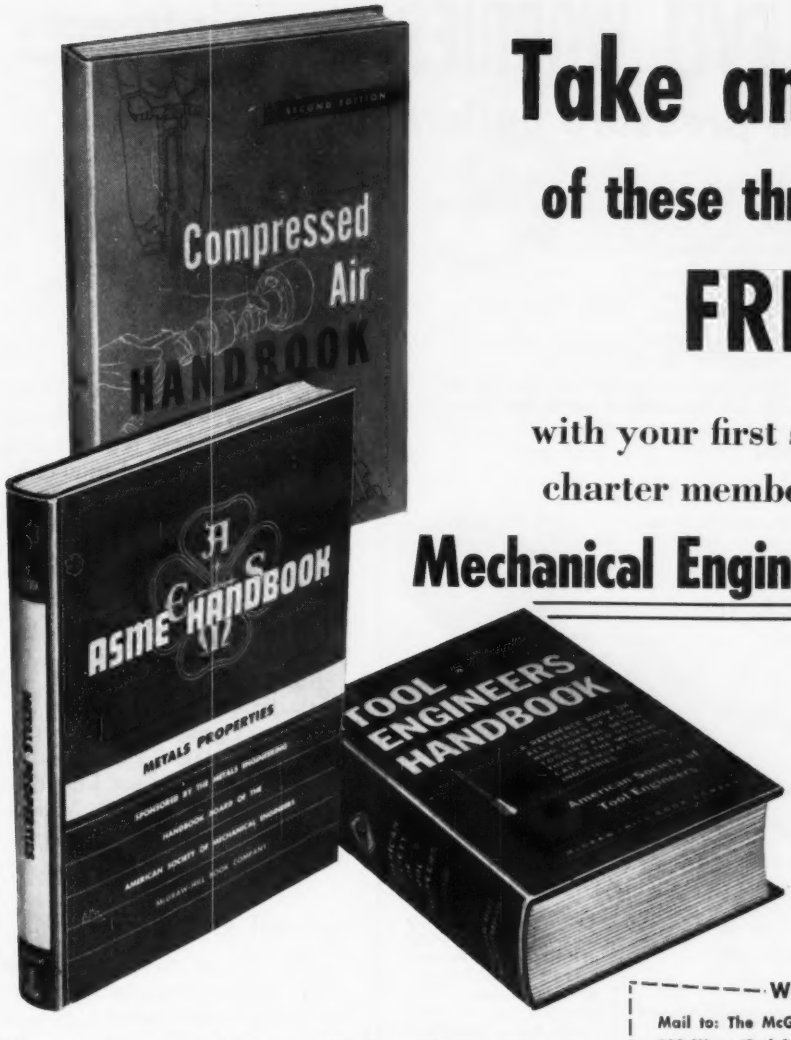

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Mechanism, by Joseph S. Beggs. Publisher's Price, $8.00 Club Price, $6.80.

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For more facts circle 299 on Reader Service Card, p 100

END WATER LEVEL WORRIES

in those medium pressure boilers

Here's the great combination that takes all the worries and troubles out of water level and feed pump control for the many medium pressure boilers—boilers with steam pressures up to 150 psi.

The drawing shows the simple hook-up. McDonnell No. 150 controls the boiler feed as it should be controlled—directly from the boiler water level. This holds the water level within the close limits that assure maximum steaming efficiency and fuel economy. Any deficiency in the returns is at once replaced by the McDonnell No. 27T Make-up Water Feeder installed on the receiver.

An extra switch on the No. 150 provides circuits for cutting off burner and sounding low water alarm—a final safeguard from emergency conditions such as current interruption in the pump circuit or failure of make-up supply.

Ask for engineering data covering all conditions. For boilers up to 250 psi. ask about the new 92 Series Pump Control.

McDONNELL & MILLER, Inc.
3506 N. Spaulding Ave.
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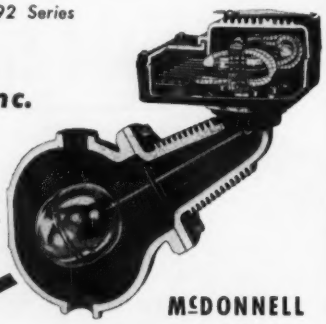
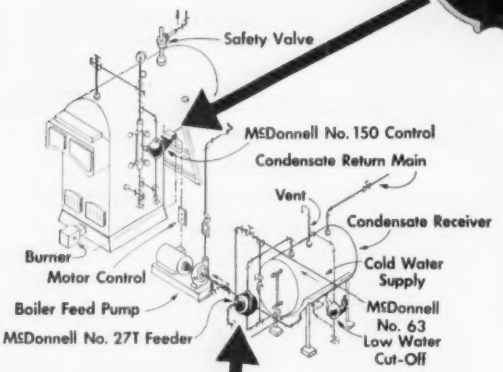
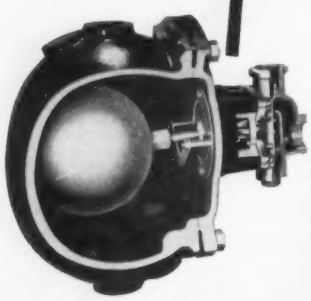
Doing One Thing Well





McDONNELL No. 150 PUMP CONTROL

The most widely used, time proved control of its type—for boilers up to 150 psi. Underwriters' Listed. Has two mercury switches—one for controlling feed pump and one for low water cut-off and alarm. Packless construction features heavy monel sylphon. Switch leads have porcelain bead insulation. Also available with water column type body—No. 157.



McDONNELL No. 27T MAKE-UP WATER FEEDER

Has large water feeding capacity which permits locating the No. 27T at a relatively low point on the receiving tank; this provides adequate space for return condensate, preventing wasteful overflow. Sturdy construction withstands turbulence in receiver. For tank pressures to 35 lbs., water supply pressures to 100 lbs. McDonnell Make-up Feeders also include flange-mounted types.

Your Jobber Stocks Them

McDONNELL
Boiler Water Level Controls

Boiler Water Feeders • Low Water Fuel Cut-Offs • Pump Controllers • Relief Valves
Flow Switches • Related Liquid Level Controls for Tanks, Stills, Air Conditioning Systems

Appointments

Corporation changes

Research-Cottrell, Inc: J M Knox, president. **Walworth Company:** J C Wallace, vice-president and general manager. **McQuay, Inc:** G G Workinger, Henry B Williams; vice-presidents. **Borg-Warner Corporation,** Byron Jackson Div: E S Dulin, board chairman; A W Rose, president.

Federal Pacific Electric Company: J S Thompson, honorary chairman; T M Cole, president. **Foster Wheeler Corporation:** Admiral E W Mills, board chairman; W L Martwick, president. **The International Nickel Company, Inc:** A P Gagnebin, vice-president. **American Radiator and Standard Sanitary Corp,** Detroit Controls Div: F J Kreissl, president.

Buffalo Forge Company: W R Heath, president. **Crane Co:** N F Garrett, vice-president. **Chemetron Corporation,** Tube Turns Div: J D Mattimore, vice-president. **Lipe-Rollway Corporation:** J D Williams, president. **Johnson Service Co:** Joe Wheeler Jr, vice-president.

General sales manager

Crosby Valve and Gage Company: J J Bresnahan, sales vice-president. **Research-Cottrell, Inc:** W W Moore, sales vice-president. **Carrier Corporation,** Unitary Equipment Div: M J Wilson, commercial air-conditioning sales manager.

Graver Water Conditioning Co: D M Spillane, manager of power-plant utilities. **Bell & Gossett Company,** Marlow Pump Div: A F Woods, general sales manager. **West Instrument Corporation:** A M Willer, sales manager.

Buell Engineering Company, Inc: C E Beaver, sales and marketing. **Minneapolis-Honeywell Regulator Co,** Datamatic Div: G S Younkin, sales manager.

New names

Slough-DeFlon: new cooling-tower engineering firm. **Compania De Laval Turbina Internacional, S A:** international subsidiary for De Laval Steam Turbine Company. **Flexonics Research Laboratories:**

testing and development division of Flexonics Corporation.

Griscom-Russell Co: new sales department for sea-water distilling plants. **Standard Pressed Steel Co:** Nuclear Components Div. **Teleflex Incorporated:** Nuclear Div. **Clark Bros Co:** Nuclear Products Dept. **Air Reduction Sales Company:** Special Products Dept.

Recent purchases, mergers

Cleaver-Brooks Company: acquisition of Springfield Boiler Company. **Thompson Ramo Wooldridge Inc:** merger of Thompson Products, Inc with The Ramo-Wooldridge Corporation. **J F Pritchard and Company of California:** merger with Dover Manufacturing Company.

Hammond Valve Corporation: acquisition of business and assets of Hammond Brass Works, Inc. **Eclipse Fuel Engineering Company:** purchase of Norwalk Valve Company. **I-T-E Circuit Breaker Company:** acquisition of Wilson Electrical Equipment Company, Inc.

Awards

W H Armacost, Combustion Engineering, Inc: The American Society of Mechanical Engineers Medal for distinguished service in engineering and science.

H J Rose, Bituminous Coal Research, Inc: Worcester Reed Warner Medal; **T P Goodman,** General Electric Company: Melville Medal of the ASME for outstanding engineering literature.

T A Fearnside, Stone & Webster Engineering Corporation: elected a fellow of the ASME.

Obituaries

H S Walker, 78, founder and board chairman of Walker Brothers, died on Sept 14th.

R W Nelson, 48, vice-president of American Air Filter Co, on Oct 9.

A A Markson, 54, assistant vice-president of Hagan Chemicals & Controls, Inc, on Nov 23.

Hooper Love, former president of West Kentucky Coal Company, on Nov 28.

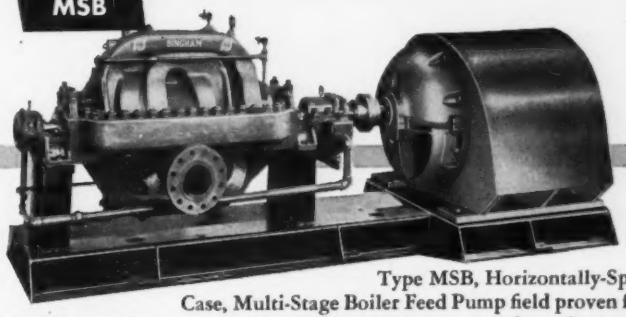
Specify

Bingham

"DOUBLE VOLUTE"
BOILER FEED PUMPS

for the ultimate in dependability
IN HIGH PRESSURE SERVICE

TYPE MSB



Type MSB, Horizontally-Split Case, Multi-Stage Boiler Feed Pump field proven for 1200 lbs. working pressure. Integrally cast cross-overs and evenly spaced case bolting located uniformly close to the shaft center line, enclosing a minimum pressure area, eliminate case distortion and inter-stage jetting.

TYPE CP

Type CP, Multi-Stage, Double-Case Boiler Feed Pump with forged outer barrel for high pressure service.

All BINGHAM Boiler Feed Pumps feature: (1) "Double Volute" construction, resulting in full radial balance of the rotating element *throughout the entire operating range of the pump.* (2) Double suction first stage for low NPSH. (3) Balanced axial thrust (no balancing drums needed). (4) Kingsbury Thrust Bearings. (5) Stuffingboxes subjected to suction pressure only. (6) Design for High Speeds.

Bingham SINCE 1921

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For more facts circle 301 on Reader Service Card, p 100

George Edwards

proposes "How to get a line on your future"

As pictures go, the one at the top of this page couldn't exactly be called exciting. It's a good shot of a guy starting a backsplice around an eye in a fair-sized hunk of line, and that's about all. I've fiddled with splicing now and then just for fun and found that while it isn't too tough to do, it isn't as easy as an old hand with a marlin spike can make it look.

What intrigues me about the picture is that it shows a job being done by a method that must be centuries old. By today's standards, the only word for it is crude. And when the splice is finished, the line will probably be used with a piece of equipment that's loaded with modern controls.

This fellow isn't making the splice by hand because he doesn't like using a splicing machine. He's doing it this way because there's no such animal in his shop—nor anywhere else. In spite of all our know-how, here's one job we're still doing in the same way it was done in Marco Polo's day.

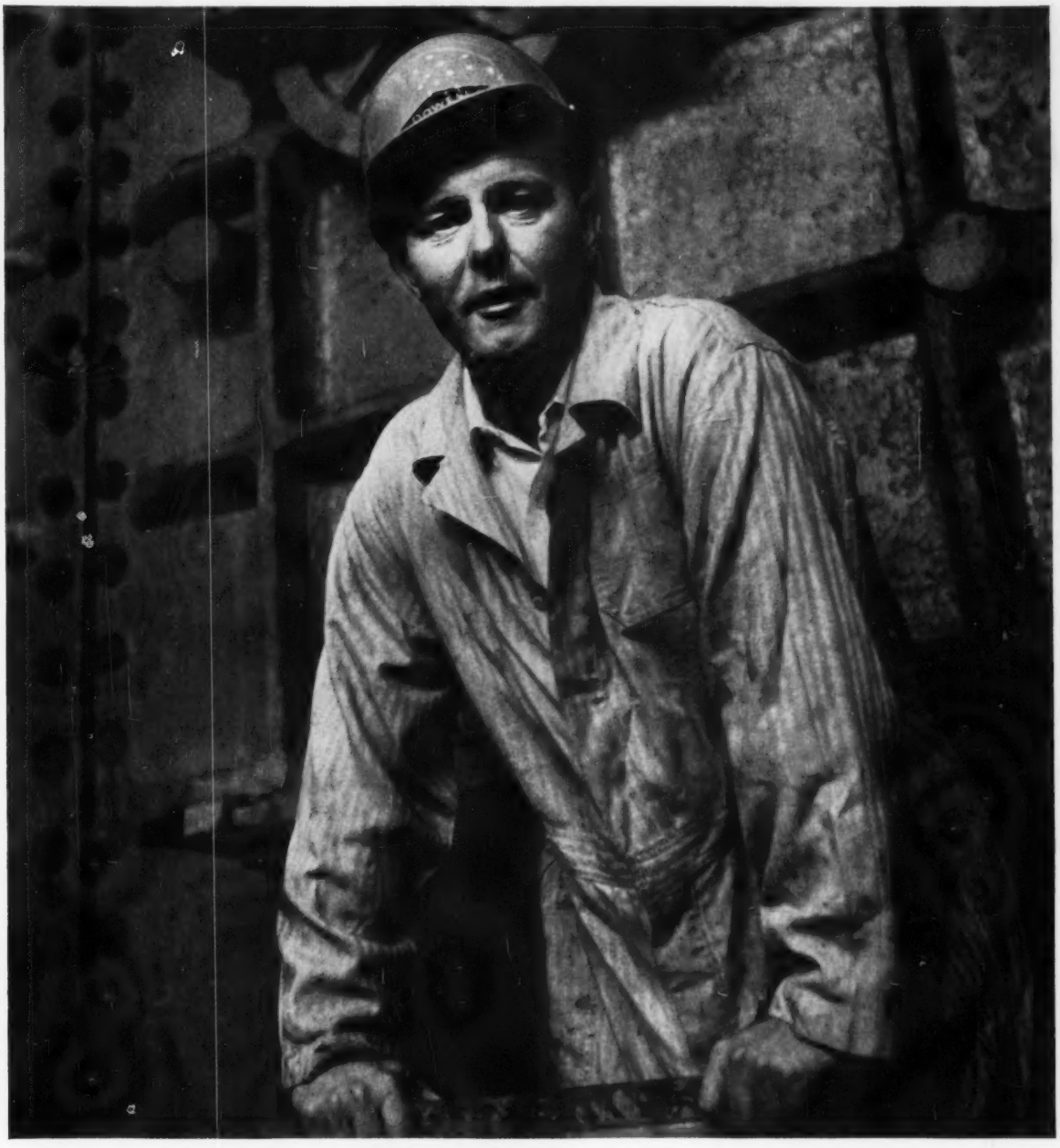
There's good reason for it, of course, and it's a reason that'll hold good from here on in no matter how much more we develop automation for our plant equipment and processes. There's a definite limit to substituting machines or instruments for the human mind, eye and hand.

No matter how we employ the split-microsecond responses of an electronic "nerve center," or how cleverly we devise a "memory" unit, the machine will be limited by what a human brain "taught" it. A machine that "thinks," in the true sense of the word, isn't any more possible than teaching a parrot to understand what it's saying. You might be able to teach a parrot to scream "Look out," but don't bank on the bird to come through when a warning might save your life.

Automation is here to stay, that's for sure. And we're just beginning to scratch the surface of what we're going to be able to do with instrumentation. Some bubbleheads still scream that it's going to put a lot of guys out of work, but I think we know better than that. However, it's going to mean separating the sheep from the goats. Tomorrow's plant "operators" will be the little black boxes instead of human beings. And the fellow responsible for these "operators" must be on the ball.

We have to depend today on a "human" mind for a backsplice because it's something a machine can't fathom. And, because no instrument will ever be able to make a decision that requires judgment, or take advantage of an opportunity, or tell us if it has a pain, we're going to have to depend more than ever on the human at the controls.

As I said, it'll separate the sheep from the goats when it comes to keeping this equipment on the line. With more and more new power plants coming along—and you can bet your hat they'll have plenty of automatic controls—it's going to mean more good jobs for good men. And how does a man get to be good enough to fit in one of these slots? I think the late Wiley Post wrapped it up neatly. Asked by a young fellow how to become a good pilot, Wiley said, "It's easy, all you have to do is know more than the airplane."



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For more facts circle 302 on Reader Service Card, p 100

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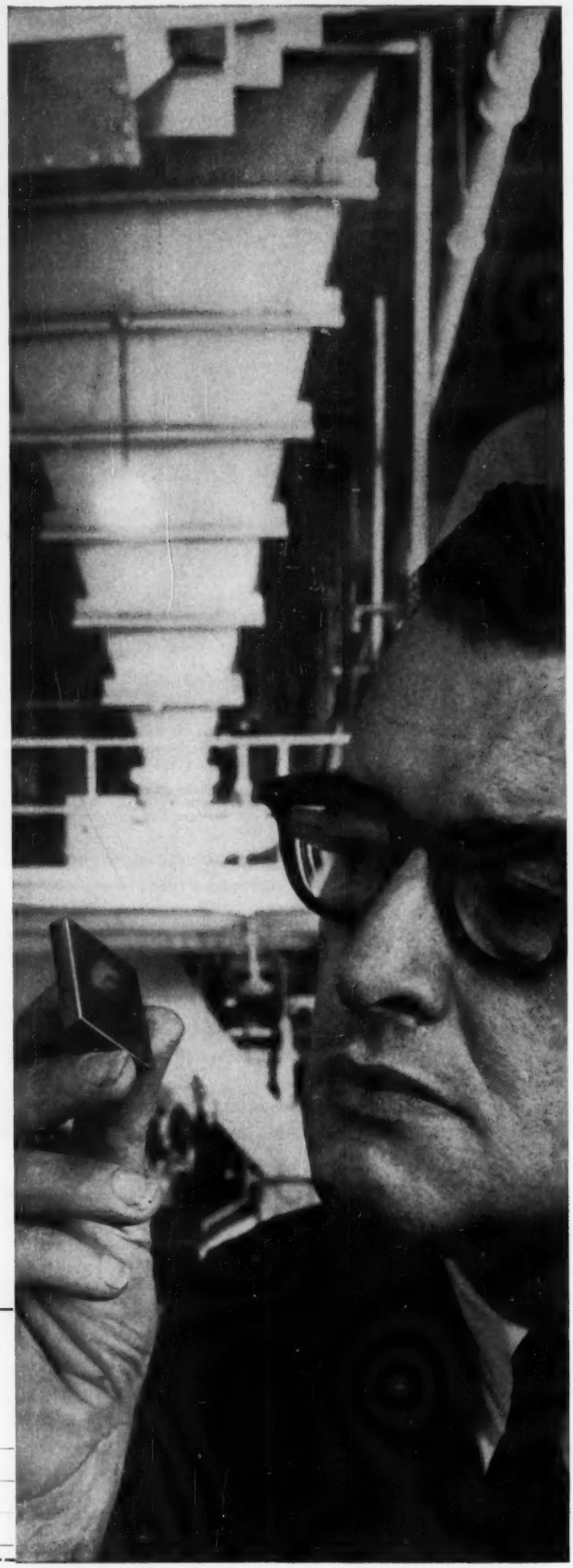

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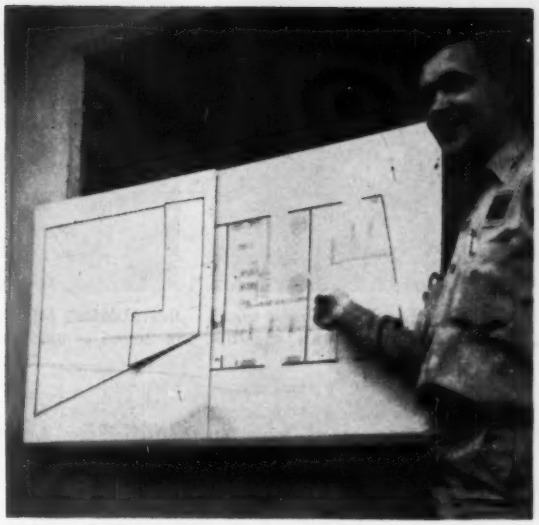
Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge



STAFF ENGINEER sells area shop installation to top management after making a complete study of the problems and needs

By RAY J STRATMEYER, Plant Engineer
John F Queeny Plant
Monsanto Chemical Co, St. Louis, Mo.

For better maintenance separate line from staff duties

Seven employees can be made to do the work of one, according to the whimsical Parkinson's law. This ancient idea is based on two axioms: (1) Officials make work for each other and (2) officials tend to multiply their subordinates, but not their rivals.

In this connection here's what we've learned about maintenance management: If one man has both line and staff duties, the line responsibilities tend to drive out the staff duties. For example, let's listen in as maintenance supervisor Joe answers his phone: "What's that, your 330-gpm pump out again? That's the third time this month. OK, Bill, we'll try a different pump. I'll see what we've got in stock and call you back."

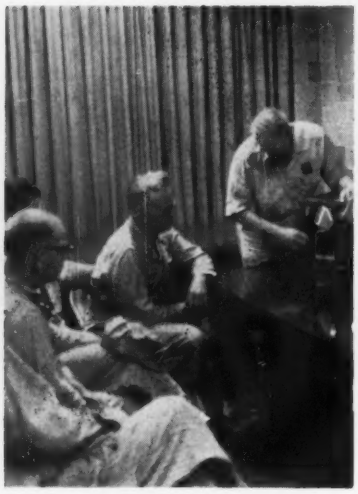
Problems like this illustrate why a maintenance department needs a staff engineering department under direct control of maintenance people. Line personnel, like Joe, can't take the time needed to check the problems that they spot. In the above case, it might take a week for a good engineer to solve Joe's pump headache. The problem must be defined. Maybe no pump will work or perhaps materials in the pump are wrong. There might be piping strains, faulty operation, etc. But if Joe took a week to come up with the solution to his problem, Area 6 would suffer. His foreman would go wild, and production people would yell bloody murder.

Here's the approach we use at our plant. We've set up a staff group to pick up problems from the line. They then go about providing sound engineering solutions. But we've found our staff isn't content to just pick problems brought out by line personnel. They question the entire maintenance operation—policies, organization, methods, skill and training, equipment, design—adding to the effectiveness of our program.

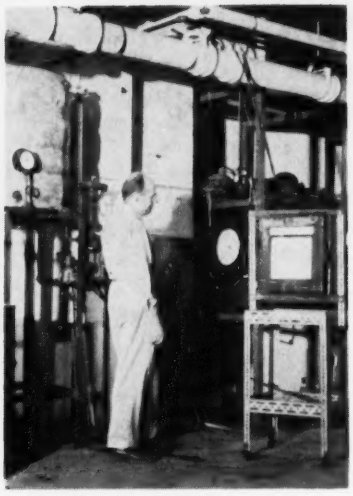
Again using Joe's pump as an example, here's how we tackle the problem: Staff men check to see if other pumps used for the same service give trouble. If so, they determine if (1) pumps are operated and maintained properly. (2) Does operator, oiler or mechanic need training? (3) Is the process OK for the particular pump? (4) Are materials and construction OK? (5) Is installation correct? After solving these problems, staff men set up a system to keep the pump running.

Turn page ▶

FOREMAN answers call after being paged. Paging encoder is at clerk's fingertips



INSTRUMENT MECHANICS take a lesson in use of oscilloscope from staff engineer



MATERIALS EVALUATION project: here steam trap is tested under load conditions

Staff has several responsibilities to the line

Typical staff functions. Maintenance facilities and tools are an important area. Punches, shears, pipe benders, rigging equipment, high-speed cutoff saws, hydraulic working platforms and other equipment need study. The staff determines what's best equipment and where it should be placed. Area shops, tool rooms, equipment storage areas fall into this phase of our program.

Maintenance systems—such as lubrication, insulation inspection and repair, group lamp-bulb replacement—are other vital areas. Another is the field of preventive maintenance. In this program, besides setting up a system, the staff may pick up the task of managing the work initiation forms, checking the reports and reviewing the economics of the entire operation.

Electrical and instrumentation area takes constant checking of wiring systems to (1) standardize circuits for easy repairs (2) evaluate electrical supply items and inventories (3) set up parts catalogs and (4) provide technical help on complex trouble-shooting jobs that might otherwise tie up a foreman's time.

Painting, building maintenance, material testing and evaluation programs all fit into the staff setup, as do grounds maintenance, streets, railroad tracks, etc.

Training is most important because of modern equipment designs and new management duties. Staff training includes everything from seminars on glandless pump design to educating area foremen in mechanical work techniques and area management. And mechanic apprentices must be selected, tested and trained to do their jobs.

Management tools and indices for controlling maintenance in a big plant take careful analysis and constant improvement. Ratio delay studies, production reports on downtime relating to maintenance, overtime controls, maintenance budgets and procedures, all fall into the pattern of responsibilities met by the staff group.

Important staff duty is to cooperate with the purchasing department on money-saving ideas or on new materials. Often, purchasing finds a supply item that could save large sums. But if it's not identical to the product in present use, either purchasing cannot get permission to make the change or the line installs the item in a restricted test. Here's where staff assistance can result in big savings. Examples are gasketing and packing, steam traps, valves, insulating and roofing materials.

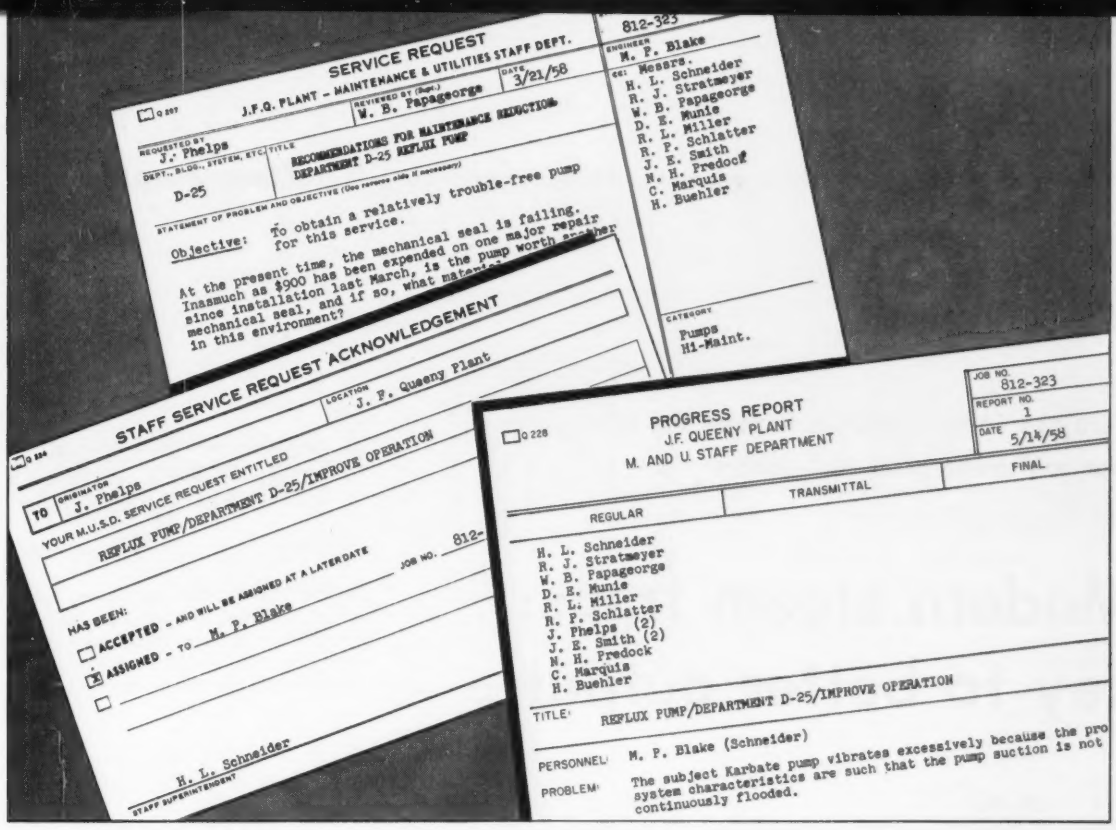
Service requests. Some type of formal request system is needed in a large plant. Our form, right, top, requires statement of the problem and objective, estimated benefits to be derived and reference to background or approach. Title, inserted by staff, is in three parts: (1) equipment or system needing attention (2) department or building and (3) description of the problem.

Staff also designates category keys for cross-reference filing. Acknowledgment form, right, center, goes back to the initiator of the request.

We encourage everyone in our plant to submit problems for study, and our staff super is required to acknowledge each request. If the project is accepted for study acknowledgement should have name of staff engineer assigned to the job. If rejected, reasons are noted.

Reports. If a request requires a lengthy study, then progress reports, right, lower, are needed to show the form that the study is taking. If interested parties can present sufficient evidence showing that a different approach is needed, we attach a notice to pass on their ideas before the study is finalized. A monthly report covers all activities of the staff in summary form.

Controls. At our plant, line organization is responsible for costs, work execution, etc. This can cause conflict. For example, if a staff man makes a study and his ideas enter into the line area of duties, and the line man doesn't agree with the answer, he has the right to reject the study. But if he does reject it a lot of val-


SERVICE REQUEST
J.F.Q. PLANT – MAINTENANCE & UTILITIES STAFF DEPT.
REQUESTED BY J. Phelps
REVIEWED BY W. B. Papageorge
DATE 3/21/58
DEPT., BLDG., SYSTEM, ETC. D-25
TITLE RECOMMENDATIONS FOR MAINTENANCE REDUCTION DEPARTMENT D-25 REFLUX PUMP
STATEMENT OF PROBLEM AND OBJECTIVE
Objective: To obtain a relatively trouble-free pump for this service.
At the present time, the mechanical seal is failing. Inasmuch as $900 has been expended on one major repair since installation last March, is the pump worth another mechanical seal, and if so, what
812-323
ENGINEER M. P. Blake
cc: Messrs.
H. L. Schneider
R. J. Stratmeyer
W. B. Papageorge
D. E. Munie
R. L. Miller
R. F. Schlatter
J. E. Smith
N. H. Predock
C. Marquis
H. Buehler
CATEGORY Pumps Hi-Maint.
STAFF SERVICE REQUEST ACKNOWLEDGEMENT
LOCATION J. F. Queeny Plant
TO ORIGINATOR J. Phelps
YOUR M.U.S.D. SERVICE REQUEST ENTITLED
REFLUX PUMP/DEPARTMENT D-25/IMPROVE OPERATION
HAS BEEN:
ACCEPTED – AND WILL BE ASSIGNED AT A LATER DATE
ASSIGNED – TO M. P. Blake
JOB NO. 812-
H. L. Schneider
STAFF SUPERINTENDENT
PROGRESS REPORT
J.F. QUEENY PLANT
M. AND U. STAFF DEPARTMENT
JOB NO. 812-323
REPORT NO. 1
DATE 5/14/58
REGULAR
TRANSMITTAL
FINAL
H. L. Schneider
R. J. Stratmeyer
W. B. Papageorge
D. E. Munie
R. L. Miller
R. F. Schlatter
J. Phelps (2)
J. E. Smith (2)
N. H. Predock
C. Marquis
H. Buehler
TITLE: REFLUX PUMP/DEPARTMENT D-25/IMPROVE OPERATION
PERSONNEL: M. P. Blake (Schneider)
PROBLEM: The subject Karbate pump vibrates excessively because the pro system characteristics are such that the pump suction is not continuously flooded.

PAPER WORK between line and staff is important. Forms shown are a service request, an acknowledgment and a progress report

uable engineering time is wasted and it becomes difficult to maintain staff productivity and morale. But we have the answer to such a situation. First, most requests are received from the line. We always keep them informed of requests submitted by others. Usually they take part in the investigations to make sure the problem has been properly defined to the staff. This means checking with line supervision. Second, a line man cannot arbitrarily reject a staff study—he must have sufficient reasons. If such reasons are lacking, the man receiving the report from both the line and staff must act as arbitrator.

In practice, we find that the line organization is eager for help. And both line and staff are in close touch as the problem is being checked.

Procedure. But a problem solved in theory isn't solved in practice. So to be worthwhile a staff study must show ways to administer in the line organization.

For example, procedure for group replacement of light bulbs could be carried to various stages of completion before it's turned over to the line for execution. It can be as simple as a final report that analyzes the economics of the problem and recommends a replacement period (six months, one year, etc). But if the study goes only this far, execution probably won't go much further.

Final staff product should include a detailed procedure—a schedule of replacements by buildings and a manpower schedule that can be turned over to the scheduling group. If special bulbs are to be used, staff engineer must decide on quantities needed and arrange for stock. Proper storeroom code numbers can then be given to the line organization. Procedure also includes a report of work completed which is compared to work scheduled.

Follow-up. In this kind of program the staff engineer must place a 'bring-up' on the study. After a year of operation, he must review the study to see if it's working as planned, or if further improvements are needed.

This follow-up is important. It's easy in a large plant to realize a saving in manpower in one phase of a maintenance operation, only to dissipate it in another. This report gathers all cost-reduction projects. It compares estimated to actual savings. Actual direct labor savings are then reduced to terms of mechanics by mechanical seniority groups.

With this report, if several projects employing a few mechanics have been placed in successful operation, steps can be taken to put these men on other work. Or if attrition has occurred, you won't have to replace the men.

Summary. Staff department must be devoted to improvement of maintenance. But to be effective, staff department must keep other departments informed through acknowledgements, reports, etc. It must also produce complete staff work, including detailed procedures, proposed assignment of authority and responsibility, and controls needed to make sure improvement is being made.

Many staff studies are reviewed periodically to prove they are working as planned. If not, corrective steps are taken. Beyond this, staff must compile a cost-reduction report to make sure savings in one area are not being squandered in other phases of the maintenance program.

Here are up-to-the-minute facts on the little giants that can stretch your fuel dollars

Modern steam traps: key to better output

By R S POLLARD
Vice-President, Yarnall-Waring Company

No matter what your steam load—a puffer in a laundry, a steam-tracer line in a refinery, or a drum dryer in a paper mill—there's a steam trap to handle it.

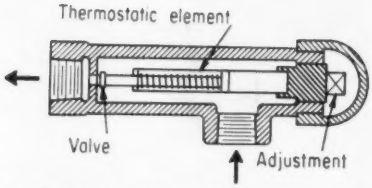
In all steam-heated equipment, when the saturated steam gives up its heat it changes back to water or condensate. Along with the steam, some air is usually carried through the system plus some other noncondensible gases, such as CO_2, which frequently form in the boiler. This can set the stage for poor equipment output.

The problem. If condensate, air and gases are permitted to build up in the heat-consuming equipment or its piping, they reduce efficiency and waste fuel dollars by forming insulating films on heat-transfer surfaces. A layer of condensate insulates as effectively as an equivalent layer of asbestos, and air and gas insulate as well as a layer of ground cork. Further, air and gas in the steam substantially lower the mixture's temperature and raise hob with the temperature difference that produces heat transfer. Table 1 shows the effects of various amounts of air in steam at pressures from 10 to 100 psig. Example: the temperature of 50-psig steam will drop down to 283 F when its air content is 20%.

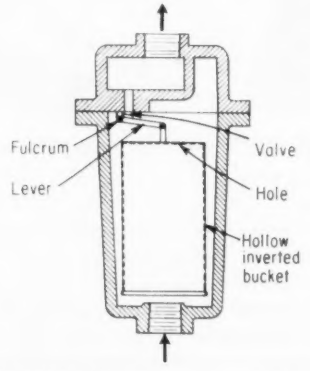
Another hazard lurking in the background is that accumulated condensate can produce water hammer. Possible resultant damage from blown gaskets, ruptured tubes, jackets and piping can mean costly shutdowns. How, then, do we get rid of condensate and trapped gases, and the troubles they may cause, without losing steam?

Many methods have been used to do this. Most elementary is a plain hand-throttling valve. This would work well if the operator were fast enough and accurate enough, if his time were cheap enough and if one could be stationed at each valve. Obviously, this is impractical.

Most efficient and most widely used method is an automatic valve or steam trap which discharges condensate and air but prevents steam from passing. Use of the correct trap on steam-heated equipment will give more production, better quality and lower costs. And the steam-heated equipment will get hotter sooner. To accomplish this, the traps must remove all the air *fast*, and discharge all the condensate *fast* and *hot*. This is what increases the equipment's production rate, improves product's quality and reduces equipment's operating cost.



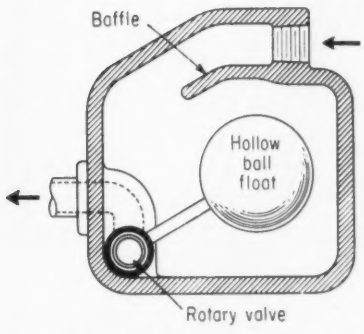
THERMOSTATIC TRAP depends on operation of a thermal element. This reacts to temperature changes — opens valve when condensate is cold; closes valve to prevent escape of steam or hot water



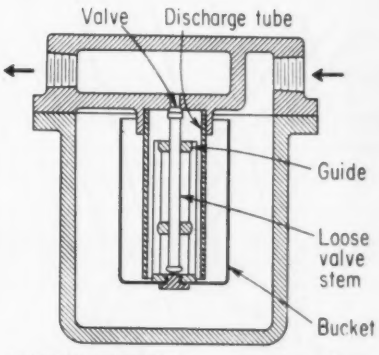
INVERTED BUCKET has a small hole in top to vent gases. With bucket down, trap discharges. Steam enters, provides buoyancy, raises bucket to close discharge valve

Trap features. No matter what type of trap is used to drain steam-heated equipment, certain design features are desirable. Besides the general condensate-handling characteristics mentioned, an efficient trap should: (1) continually sense and respond to condensate conditions in the line ahead of the trap and discharge condensate soon after it forms (2) be simple in design, with few moving parts (3) have a wide pressure range without valve adjustment or seat change (4) be small enough and light enough to be easily supported by the pipeline (5) be made of materials that deliver long life and trouble-free service (6) have a

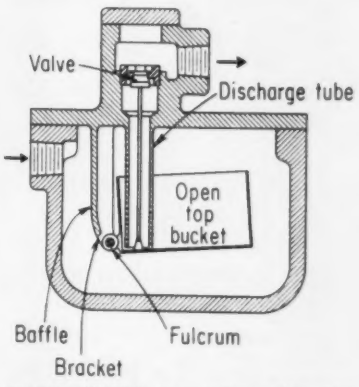
are typical thermostatic, mechanical, thermodynamic units used today



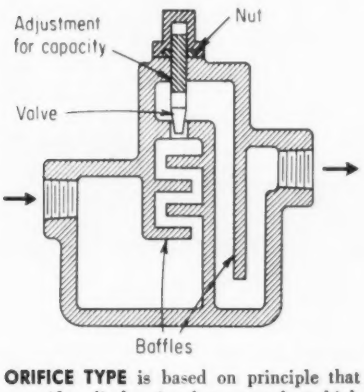
BALL FLOAT has normally continuous discharge, operates without regard to condensate temperature. Most are direct-acting. Float position controls the valve opening



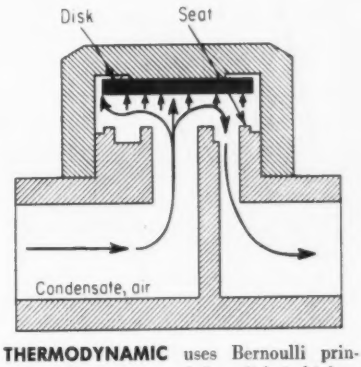
TYPICAL BUCKET has cyclic action. Open bucket floats on collected condensate until water overflows into bucket which eventually sinks and opens the discharge valve



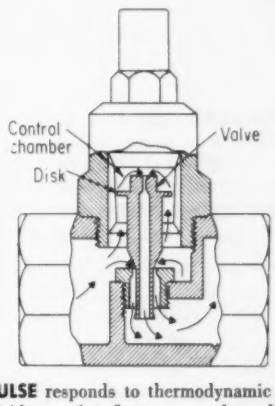
TILTING BUCKET has similar action. Condensate leaves trap through central uptake. Water level drops, no more enters bucket. Bucket is emptied by steam pressure in trap



ORIFICE TYPE is based on principle that an orifice discharging hot water from high to low pressure tends to regulate flow rate in inverse relation to water temperature



THERMODYNAMIC uses Bernoulli principle. First, pressure below disk is higher, opens valve. Then pressure differential is gradually reversed, closes discharge valve



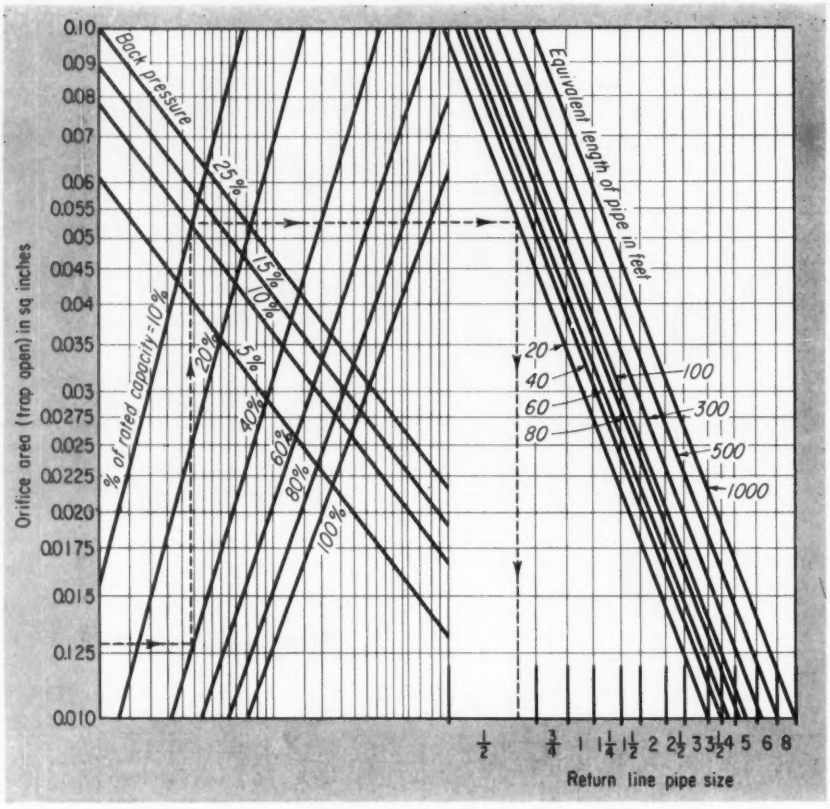
IMPULSE responds to thermodynamic state of fluid as pilot flow passes through two orifices in series. Pressure between orifices actuates valve, controls main flow

relatively low initial cost (7) be readily available from suppliers (8) be nonfreeze for general use anywhere.

Air-handling capacity of a trap is extremely important. As we've noted, failure to remove air and gases quickly can result in air binding and backup of condensate in equipment. Result: poor performance. Air-handling capacity depends on the effective pressure available for forcing air through the vent as well as the size of the vent. In some traps the effective pressure acting to force air through the vent may be about 0.07 psi when the trap discharges from 100 psi to atmospheric pressure. In other traps the effective pressure under the same conditions will be 100 psi. Thus, the latter trap has an effective pressure 705 times as great when considering the critical pressure due to flashing immediately downstream of the orifice. Too, this trap's air-handling capacity would, of course, be greater. (The figure 705 is derived from the fact that at 100 psi hot condensate flashes immediately downstream of the orifice, producing a critical pressure equal to 49% of the inlet pressure at orifice. Therefore effective pressure causing flow through orifice in this case is difference between critical pressure and upstream pressure, or 51% of 100 psig, or 51 psi, and $51/.072 = 705$.)

Air-venting area of traps varies with the size and design of the vent opening. In some designs the venting area is many times as large as in others. When effective pressure and venting area of different traps are considered, one trap may have as much as 200 times the air-handling capacity of another. Large air-handling capacity insures a shorter warm-up time for equipment, giving greater output at lowest cost. It's obvious then that air-handling capacity should be checked when selecting traps.

Keeping equipment hotter so it will produce more output depends on a continuous flow of steam to the equipment. And steam will flow into a unit more effectively when the trap continuously tests for condensate cool enough to discharge. For best unit



RETURN-LINE SIZE must be big enough to prevent excessive backpressure. Chart shows factors necessary, how to use them to get proper size

Don't use "rule of thumb" methods in picking trap sizes

performance, condensate should be discharged as close to steam temperature as possible. On-off operation of the trap may not insure condensate discharge within this temperature range. The impulse type trap, for example, using the thermodynamic principles of two orifices in series, continuously samples and discharges condensate. Its closing range is from 4 F below steam temperature up to the steam temperature.

In any steam trap, the hotter the condensate discharged, the greater the flash steam. Table 2 shows that if 0% flash is desired with condensate discharging at 100 psi, it will be necessary to hold this condensate back until it cools to 212 F, or 126 F below steam temperature. While this is taking place, condensate will naturally back up in the equipment and lower efficiency. When this condensate is discharged as quickly as it is formed right at steam temperature, it'll produce 13.3% flash. Thus, flash should be expected from any trap operating at high efficiency.

Nonfreeze operation is extremely important in cold climates. Traps that store a quantity of condensate before discharging or require water sealing may freeze when shut down. Resulting breakage or other damage to the trap and its piping can be costly. A trap that continuously discharges hot condensate without storage will not freeze, if properly piped, because the trap is self-draining on shutdown.

Steam leakage through a trap is wasteful because such steam does little or no useful work before it enters the return system. So positive shutoff of the steam is important consistent with complete air, gas and hot condensate removal. While mechanical and thermostatic shutoff devices are effective, they may be subject to leakage due to loss of prime, wear, corrosion or water hammer damage. With an impulse type trap, using the thermodynamic principle of two orifices in series, there is positive control flow to satisfy all mean requirements. Differential pressure supplies force needed to give effective valve closure on steam.

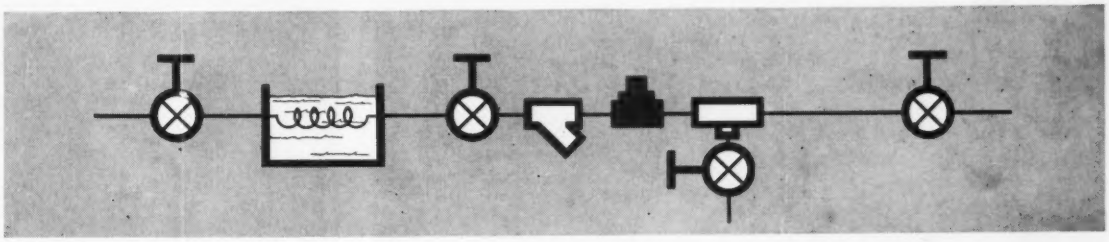
Return lines. Successful trap application depends on many factors. One of the most important of these is the size of the return line. Return piping must be large enough to prevent excessive backpressure. Chart, above, shows how proper piping size may be easily found. Enter chart

1—Temperature loss from air in steam

Pressure psig	Steam temperature	Percent air in steam 10%	20%	30%
10	240 F	6 F	12 F	19 F
25	267 F	6 F	13 F	21 F
50	298 F	7 F	15 F	23 F
75	320 F	7 F	15 F	24 F
100	338 F	8 F	16 F	26 F

2—Flashing effect at 100 psig

% flash	Condensate temp	Temp drop
0	212 F	126 F
5	240 F	98 F
10	306 F	32 F
10.8	314 F	24 F
11.6	322 F	16 F
12.4	330 F	8 F
13.3	338 F	0 F



CORRECT INSTALLATION is of great importance if a trap is to deliver the high standard of performance designed and built into it. Large and expensive process equipment depends heavily on trap efficiency despite trap's relatively small capital cost

from left at orifice area. Where this horizontal line intersects the "percent of rated capacity" line draw a vertical line upward to the appropriate backpressure line. From this intersection draw a horizontal line to the right to the appropriate "length of pipe" line. Draw a line vertically downward to determine return-line size. For more than one trap, work each one through the chart and add areas to get overall pipe size. The "percent of rated capacity" line is determined by dividing 100% by the factor of safety used.

Example: What size return line should be used with a trap having an orifice area of 0.013 sq in. if the factor of safety is 2.5, backpressure is 10% of inlet pressure and equivalent length of return line is 20 ft?

Solution: Enter chart on the left at the orifice area of 0.013 sq in. and project horizontally to the right to the 40% rated capacity curve (100%/2.5). From here, project vertically to the 10% backpressure curve, then horizontally to the equivalent length of the return line (20 ft). At the bottom of the chart, read the return-line size as ½ in.

Trap choice. Choosing the proper trap to meet operating conditions is a big factor. If a batch process, trap should be able to handle a lot of air quickly to bring each batch to temperature as rapidly as possible. Once at holding temperature, trap should handle a minimum load efficiently and with maximum speed. If a continuous process, air-handling ability becomes secondary, though it's convenient to have for emergencies and quick starting.

Correct trap sizing is a cinch—when you know how. Rule-of-thumb methods don't apply here. One of the most deceiving is to size the trap to match the condensate outlet on the jacket or coil. The trap should be neither too large nor too small. Oversizing may cause excessive pressure drop on discharge, sluggish operation due to steam binding. Undersizing makes for inefficient condensate drainage and production loss. Pick the trap from manufacturers' capacity tables. Most provide for trap selection after you've calculated your condensate load. One of the easiest and simplest tables to use is that provided for the impulse trap. Requiring no condensate load calculations, trap size can be picked from the table, once equipment size and steam pressure is known. And speaking of pressure, in determining the pressure at which your trap will operate, use trap inlet pressure—*not* boiler pressure. There's pressure drop between boiler and trapped unit, plus a further drop through the unit. Too, you may have overlooked pressure-reducing valves upstream.

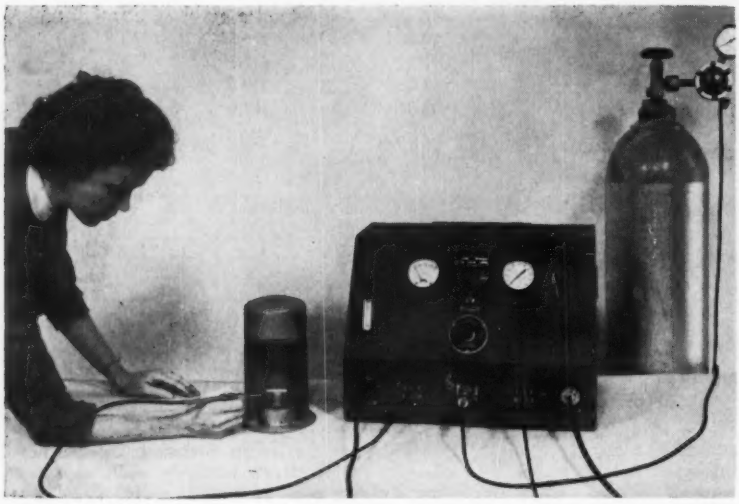
Factor of safety, or safety load factor, must be chosen to take care of cold startup which gives high condensate loads. From your capacity tables choose safety load factor applying to your equipment. Then use capacity table according to manufacturers' instructions. All capacity tables show maximum values. Forgetting the safety load factor causes trap to operate wide open much of the time—a bad condition. Factor varies with process to be trapped, trap style and type of steam-heated equipment. Factors may vary from a low of 2 to a high of 10 or 12.

Needless to say, traps must be installed correctly and this must be followed by a good preventive maintenance schedule. All trap manufacturers can supply detailed instructions in connection with these important factors.

Most traps are inexpensive. If properly selected, installed and maintained, they'll contribute greatly to overall process efficiency. Much large and expensive equipment can function well only through proper trapping. Thus trap application looms much larger in importance than indicated by the relatively small cost of the trap when considering overall economy of equipment operation.

OPERATORS' NOTEBOOK 125

Now you can cut any



CUTTING UNIT is a 110-volt 60-cycle device that uses an inert dry-cylinder gas as a propellant. The handpiece is adaptable for either manual or automatic operation

PERFECT SLICE is removed from this brittle light bulb leaving no sign of shatter

Here's what you can do

All you plant maintenance men have run up against the problem of cutting or shaping brittle material to fit a special need. But how many times have you had to use a less-brittle part because you didn't have the tool called for by the job. That is no longer a stumbling block because here is a tool you can use for cutting anything brittle. Have doubts? Then cast a glimpse at the light bulb in the photo, above right.

Cutting unit is a high-speed precision device that uses gas-propelled abrasive powder as its cutting medium. Put it to work for cutting, abrading, removing surface films, deburring small areas, etc, depending on needs.

Cutting stream travels at 110 ft per sec. Kinetic energy thus produced, plus expansion of the propellant gas, produces a cool shockless cutting action. This makes the tool ideal for cutting hard brittle materials such as glass, germanium, ceramic materials, etc, or for abrading parts that might be damaged by heat.

Present uses include: (1) Cleaning dies through which fine tungsten wires are drawn. (2) Precision calibration of laboratory glassware. (3) Cutting crystalline substances that otherwise might shatter or be distorted from heat vibration or contact-cutting methods. (4) Cleaning interior leads and wires of long-stem vacuum

And here are answers to your questions

What is narrowest cut that can be made?
By using the rectangular nozzle with an orifice of 0.006x 0.060 in. at nozzle tip distance of about 1/32 in., cuts of about 0.008-in. wide can be made. With 0.018-in. diameter nozzle, the cut will be about 0.018 in. when the nozzle-tip distance is about 1/32 in.

What abrasive is used?
Abrasive used is aluminum oxide, carefully classified to a close particle size range (27-micron average). A lighter abrasive (No. 2) is also used. Classified as dolomite, it's a calcium magnesium carbonate. Both powders are supplied by instrument maker and have proper flowing and abrasive characteristics. They're nontoxic (don't contain free silica, other injurious materials).

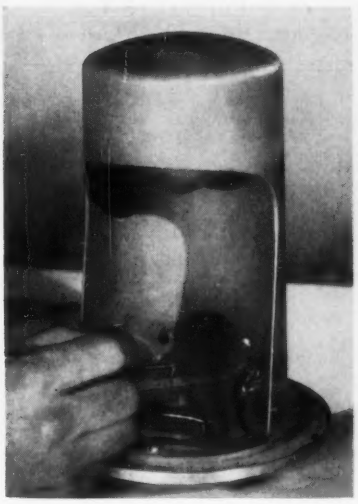
Can other abrasive be used?
Usually not because other abrasives aren't classified close enough to have proper flow or cutting characteristics. Too, they may contain free silica or other ingredients that may be harmful to the user's health.

Can abrasive powder be reused or recovered?
No. Spent powder loses its cutting points and edges, would be inefficient if reused. Recovered powder may be contaminated and would clog small orifices of unit.

brittle material

By STEVE ELONKA, Associate Editor

INSIDE THREAD is cut into end of a glass tube, similar to threading piece of metal



THIN METAL plate is cut inside work-hood that's connected to dust-collector system

UNIT DRILLS 0.03-in. dia contact depression in quartz disk to 0.015-in. depth

tubes. (5) Removing oxidation from metals, metallic smears from ceramics and dirt from small parts or holes. (6) Drilling holes, etching and grooving in ceramics, glass and hand-polished plastics.

You can make a minimum cut of only 0.008 in. Diameter of cut increases in relation to the distance the nozzle is held away from the work. Reason: the abrasive stream diverges from the nozzle at a 7-degree angle.

Cutting speed depends on: (1) Distance of the nozzle tip from the surface of the work piece. (2) Richness of the abrasive mixture. (3) Pressure of the propellant gas (usually 80-psi cylinder-tank pressure). (4) Type of abrasive powder. (Although carefully controlled 27-micron particle size is used, the action can be varied from polishing to fast cutting by using powder with different degrees of abrasive qualities.)

Operation. Unit is connected to a cylinder containing an inert dry gas and is operated on a 110-volt 60-cycle electrical supply. Gas feeds into a special vibrating mixing chamber containing the powder, then flows out through the nozzle. The gas stream can be started and stopped by either a foot switch or an automatically activated switch. The entire unit (exclusive of the gas cylinder) weighs only 44 lb, measures 12x12 in. high.

How long will a charge of abrasive powder last?
This depends on mixture's richness. At 7 gr per min. (avg flow), charge lasts 1 hr continuous operation.

What is life expectancy of the nozzle?
While nozzle life varies with its applications, average life is 15 hr for either a straight or angle nozzle.

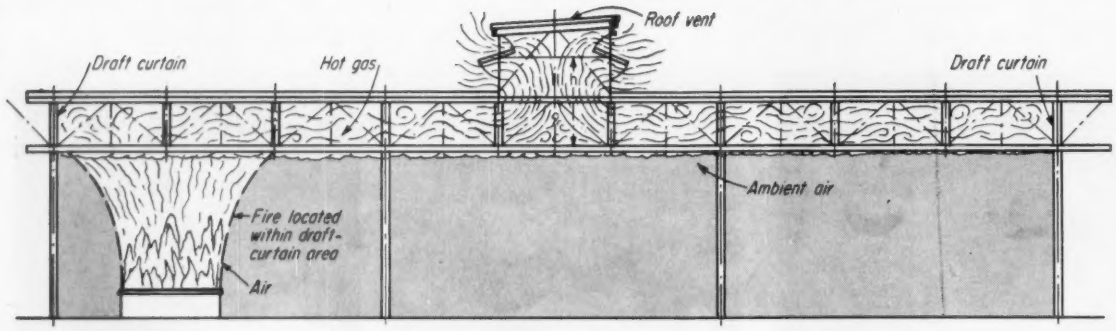
What is velocity of the abrasive stream?
Stream speed as it comes from nozzle is about 1100 fps.

What gases can be used as propellants?
Carbon dioxide is preferred because of its availability. But other suitable dry-cylinder gases such as nitrogen or air can be used. NEVER USE OXYGEN!

Can compressed air from shop lines be used?
No. Usually compressed air from shop lines is contaminated with moisture and oil which hamper operation.

What is the gas consumption of the unit?
In normal operation at 75-psi nozzle pressure, unit uses about 1/3 cfm. This means a standard 425-cu-ft CO_2 gas cylinder lasts about 21 hr continuous operation.

—Courtesy, S S White Industrial Div, New York, N. Y.



BURNER in model acts as actual fire. Studies related draft-curtain (ceiling gas barrier) depth and area, gas and air temperatures, ceiling height, and heat vented in Btu per min. Burner (4300 Btu/min at ⅛ scale) equaled 775,000 Btu/min plant fire

Hot gases from plant fires, rather than fire itself, often weaken or destroy roof structural members. That's why . . .

Effective venting helps cut fire loss

In any serious plant fire, smoke and hot gases can quickly concentrate enough heat up under the roof to weaken the structural supports. This is particularly true in large flat-roofed buildings. Effective gravity ventilation can limit this damage, but how do you know if your vent system is adequate? A research program set up by General Motors' Argonaut Realty Division after the Livonia fire produced this answer.

Heat-Power Research Lab of Armour Research Foundation did the work, using a scale model of welded-steel framework with asbestos cement ceiling and floor. Pretest studies on the 15x18-ft model set up usable relationships for full-scale application of the test results.

Both monitors and unit type ventilators were used to find: (1) best ratio between vent and floor areas and percent of heat exhausted with each ratio (2) effect of vent spacing, ceiling height and draft-curtain area and depth on venting efficiencies.

Three scales were adapted to this model—¼, ⅛ and 1/16—with bays sized at each scale to equal a life size of 40x48 bays and a 20-ft ceiling. Vents placed every two bays and opened by different patterns let the researchers study a wide variety of situations. Movable burners created the fire and allowed a study of fire location.

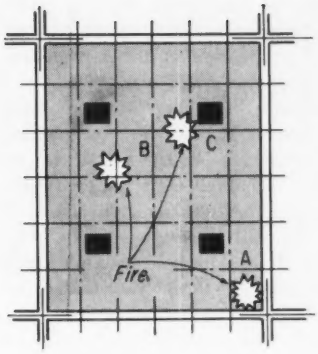
Test results show that although unit vents do a good venting job, they're not the best to install. Most desirable unit vent spacing is one vent every four bays (one diagonal bay from the vent to the fire source, or 63 ft).

To get positive opening of vents keep your draft-curtain areas to nine bays (use nonflammable curtains such as sheet steel). Actually, venting doesn't change much regardless of curtain area if you've got uniform spacing of vents and they're all open. Deep curtains (12 ft instead of 6 ft) help venting when surrounding special hazard areas and in vent-to-floor ratios between 1:50 and 1:100.

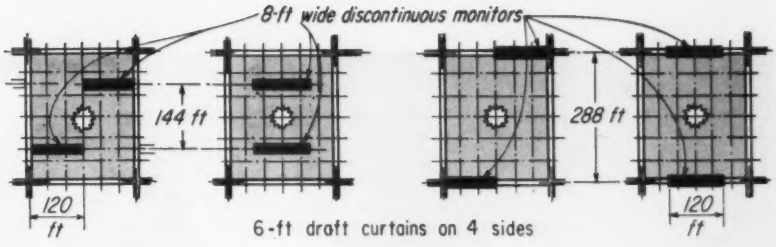
With fusible-link vent controls, space vents one to every four bays. A wider spacing is OK with dependable openers, but if you have any special fire points (paint booths, quench tanks, ovens) put 50 sq ft of vent opening right over the fire spot and combine that with a one-bay draft curtain. Ceiling height (20 to 40 ft) doesn't seem to have much effect unless you spot vents closer than one every two bays.

Along with vent spacing you have to consider the size of the opening. The area needed depends on the type of hazard. For minor hazard areas use a vent-to-floor area ratio of about 1:150. Normal hazard spots will need a 1:100 ratio, and major danger areas take a 1:30 ratio.

Two other factors studied were effect of exhaust fans and sprinklers. Your fans create a negative pressure in the building. The hot gases from a fire are generally about equal to this pressure and won't vent well. So the best thing to do if fire breaks out is to turn off the fans and let the gravity vents do the work. About sprinklers, the researchers found they have little effect on the vent area you need. A sprinkler spray cools gases, reducing expansion. But, although there isn't as much volume, the gases move slower and the necessary vent



FIRE LOCATION in 36-bay area enclosed by 6-ft draft curtains affects venting. Percent of heat vented varied from 17% at *A* and *B* to 38% at *C*. Corner walls had little effect but cutting draft-curtain area to nine bays upped venting percent to 52. Omitting draft curtains cut the heat exhausted to a low 7%



Monitor spacing-feet	Percent heat vented	Vent-to-floor ratio
144 (3 bays)	41	1:36
144 (3 bays)	31	1:36
288 (6 bays)	22	1:72
288 (6 bays)	19	1:72

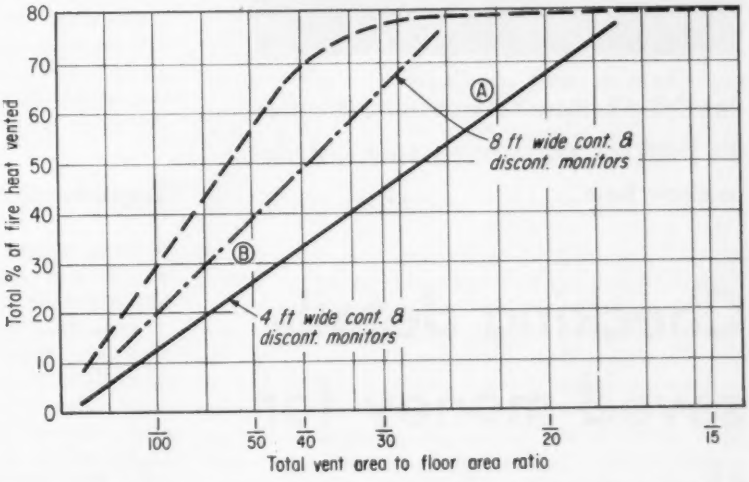
STAGGERED MONITOR (long skylight vent) is better than inline, but both need four curtains. Continuous monitor acts as gas barrier, needs curtains only across openings

area tends to stay the same. Even though you have sprinklers installed, don't figure on using smaller vents; go ahead with the building study as though the sprinklers weren't there.

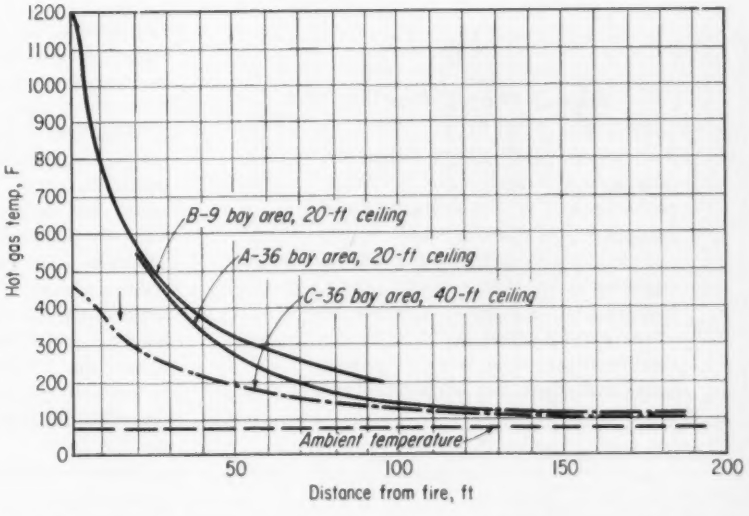
Monitor spacing turned out best with one every 3-bay interval. Although monitors don't vent as well as unit vents, they're still better to use, since they do away with two draft curtains. They act as a smoke or gas barrier—just like a draft curtain—so using continuous monitors means draft curtains are needed only crosswise to the monitors.

Distance between monitors again depends on the fire hazard, with 160-, 120- and 80-ft intervals being good for the three hazard degrees.

These tests don't mean that gravity venting does away with sprinklers and other fire equipment, nor are they hard and fast rules for all one-story flat-roofed buildings. They show how venting helps get hot gases out of the building so your regular fire-fighting equipment can do a better job. Results are general, aimed at G.M. plants only, but they help make local plant studies effective.



COMPARISON of monitors and unit vents seems to favor unit vents. Using actual effective area shifts monitor curves so efficiencies of two types are about the same



GAS TEMPERATURE drops quickly as gas travels from fire. Raising ceiling has more effect than changing curtain area. Results indicate position, setting for sprinklers

Ben Spivak, New York consultant, opens his book of engineering case histories to show how...

Checking details saved money for three customers

About the author

Ben Spivak possesses an impressive background in design and operating problems for all the power services. In twenty-plus years spent designing and trouble shooting, his practical engineering cut many plants' costs. Ben conducts a private campaign to prove careful analysis of ordinary improvements often reveals savings, large and small, but all worthwhile.

Greater production with less steam

What can be done to double production when a boiler plant barely supplies existing loads? How can it be done at minimum expense? The answers to these questions show the advantage of integrated engineering.

The plant we're concerned with produces milk powder from fluid milk, a process that involves evaporating the water from milk in two stages. In the first stage, an evaporator or "pan" boils off about 80% of the water using steam at 9.5 psia. The thickened product is atomized at high pressure and sprayed into a drier. Here, remaining water is driven off and original milk solids discharged in dry powder form. Air heated by external steam coils blows into the drier to mix with the atomized milk liquid. Air, containing evaporated water, discharges outdoors.

Boiler plant. A 350-hp watertube and a 250-hp firetube boiler furnished plant steam. The former used twin spreader stokers and operated continuously at an unbelievable 260% of rating for almost 15 hours a day, for six months of the year. The smaller boiler used an underfeed stoker at a puny 160% of rating only because it could do no better. There was no space inside or outside the boiler room for installing an additional

Trouble shooting one modern bank's

A bank, modernizing, installed an air-conditioning system for year 'round use. Modernization was completed just as cooling season started. System worked fine.

Troubles. But when heating season began, problems developed. Space couldn't be heated to a comfortable level. Only by increasing coil supply-steam pressure could comfortable temperatures be maintained. However, increased pressure caused overheating of the rest of the building and brought complaints from other tenants. Also, building owner's fuel bills increased.

Building management finally decided to ask the bank

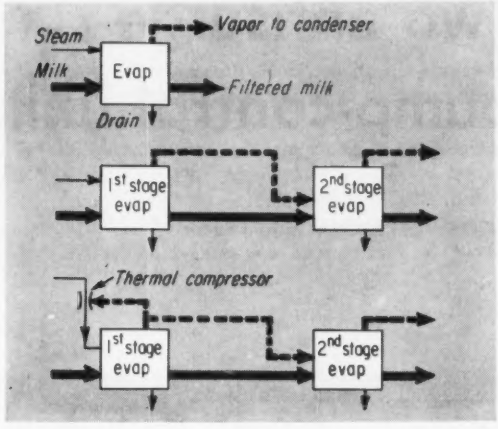
Changing a single pipe reduced

Equipment, like people, bears out adage "out of sight, out of mind." And this forgetfulness can be costly. A good example is the case of the plant I inspected some years ago for possible operating economies.

Situation. The plant was old and located in an industrial neighborhood of a large city. The original small residential flats were degraded into individually owned loft buildings and were finally acquired by the plant to accommodate its expansion needs. Since the buildings were used primarily for storage and secondarily for marginal manufacturing processes, improvements upon acquisition were kept to a minimum. The buildings were steam heated with a heterogeneous array of one pipe gravity, two pipe gravity, vapor and vacuum systems. In this respect, they did not differ greatly from the existing plant which was of the sprawling multiple-building type.

Condensate from all these buildings returned to the

saved this plant $80,000 in expansion costs



boiler. Space restrictions and the need for minimum service interruption would make replacing the smaller boiler with a larger one a costly $80,000 investment.

Procedure. Analyzing the possibilities I found one way to increase production while reducing steam load.

First, we made the existing single pan the second unit of a double-effect evaporator by adding a new first effect. This about doubled product output from 14,000 to 30,000 lb per hr. Then we installed a thermocompressor to take the vapors generated by the boiling milk and compress them with 125-psig steam for reuse in first effect. This reduced steam requirements from the original 14,000 lb per hr to 9000 lb per hr. Changes resulted in a 3.3:1 increase in evaporation efficiency.

Second, instead of increasing drier dimensions to get extra capacity, we upped air temperature by firing gas directly into the air downstream of the heating coils. Cost of this setup was less than that of adding to the drier and making necessary changes to ductwork, fans, coils, etc for increased air requirements. Gas equipment was designed to handle the whole drying load without use of steam, so an additional 8000 lb per hr were available for other uses.

Results. In this way we avoided investment of $80,000 for a new boiler installation, almost doubled output of milk powder, cut steam plant load by 13,000 lb per hr and saved on investment for increased drier capacity.

air-conditioning system saved $2000 in piping changes

to pay for piping changes in the boiler room that would permit (1) supplying higher-pressure steam to the bank's air-conditioning system and (2) reducing pressure for distribution to other tenants. Cost of changes—$2000.

Solution. When the bank received contractor's proposal for the change, they asked me to review it. Cooling and heating requirements of the space were calculated and the equipment checked for capacity. System proved to be properly designed and sized and there seemed to be no apparent reason for the difficulty.

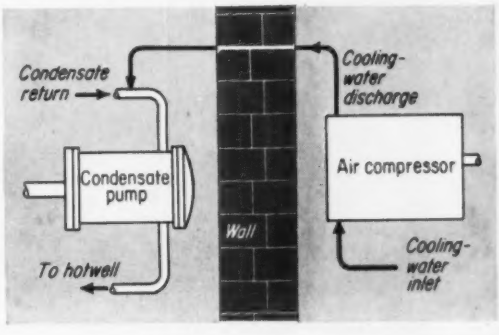
In observing the operation of the system, I noticed the automatic steam control valves on the supply to the heating coils never fully opened. A check of the control system revealed that the designers provided both a return air thermostat and a room thermostat, with a selector switch to choose which would control the system's operation. Without occupant's knowledge, someone had set the return thermostat to 60 F to assure maximum cooling. So although room thermostat was set for 75 F, room temperatures were below 70 F. No one had thought to set the selector switch for room thermostat control. The invisible became obvious and the bank saved $2000.

pump water requirements, saved $750 per year

main boiler room which supplied all buildings with steam for space heating and process. Returns connected into a common line and fed into a reciprocating steam-driven pump which discharged into a hotwell.

Time improved neither pump nor piping so cold-water injection into pump suction was necessary to maintain low suction pressures without steam binding. Amount of injection progressively increased and at the time of the survey was more than 10 gpm.

Improvements. In adjoining space, separated from the pump room by a firewall, was a relatively modern 2-stage duplex steam-driven compressor supplying 1000 cfm of air at 80 psig. It used large quantities of cooling water which were discharged to waste. The installation of a cooling tower for the compressor and other extensive changes recommended for boiler room and processes were planned for some time in the future. Meanwhile a simple expedient made possible immediate



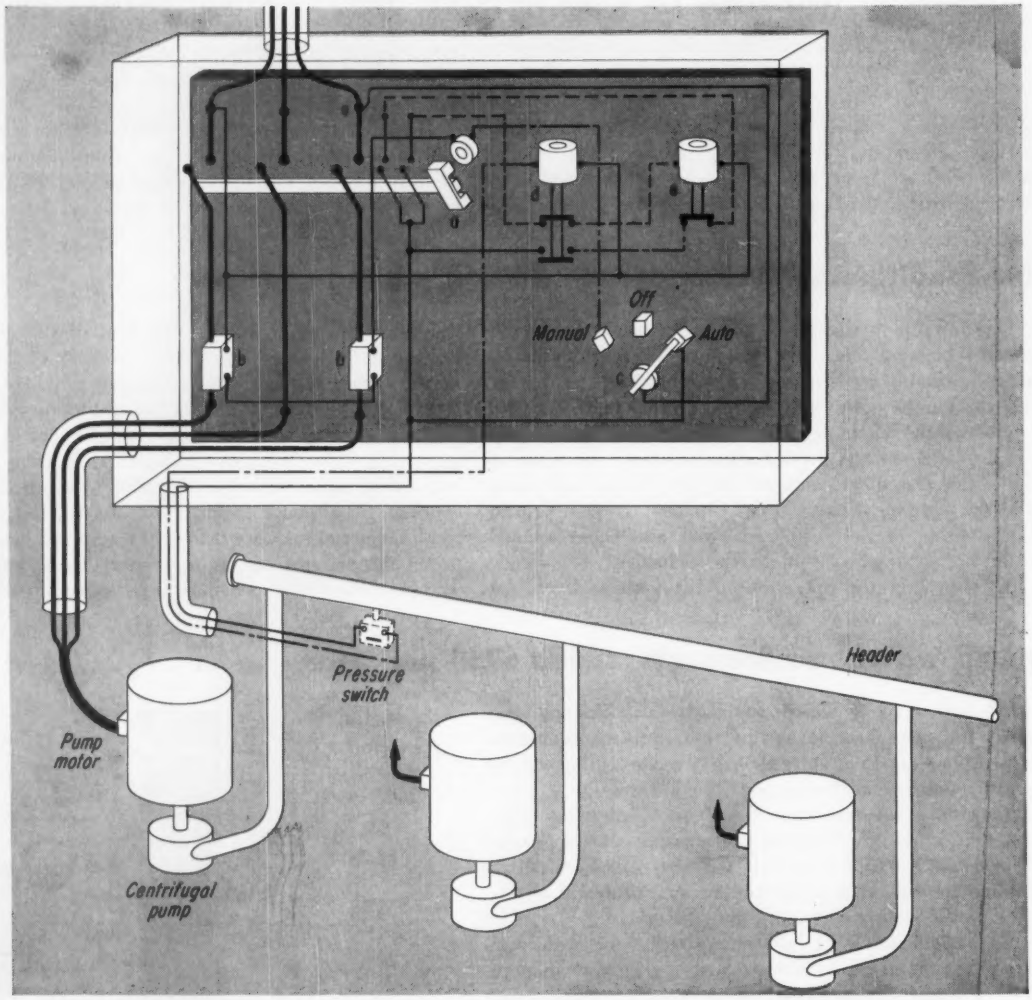
savings. A little work and less money connected the originally wasted air-compressor cooling-water discharge to heating-pump suction. The 10 gallons of city water used previously and $750 per year were saved.

Plant
Electrical
Fact File

NO. 32: PUMP CONTROL

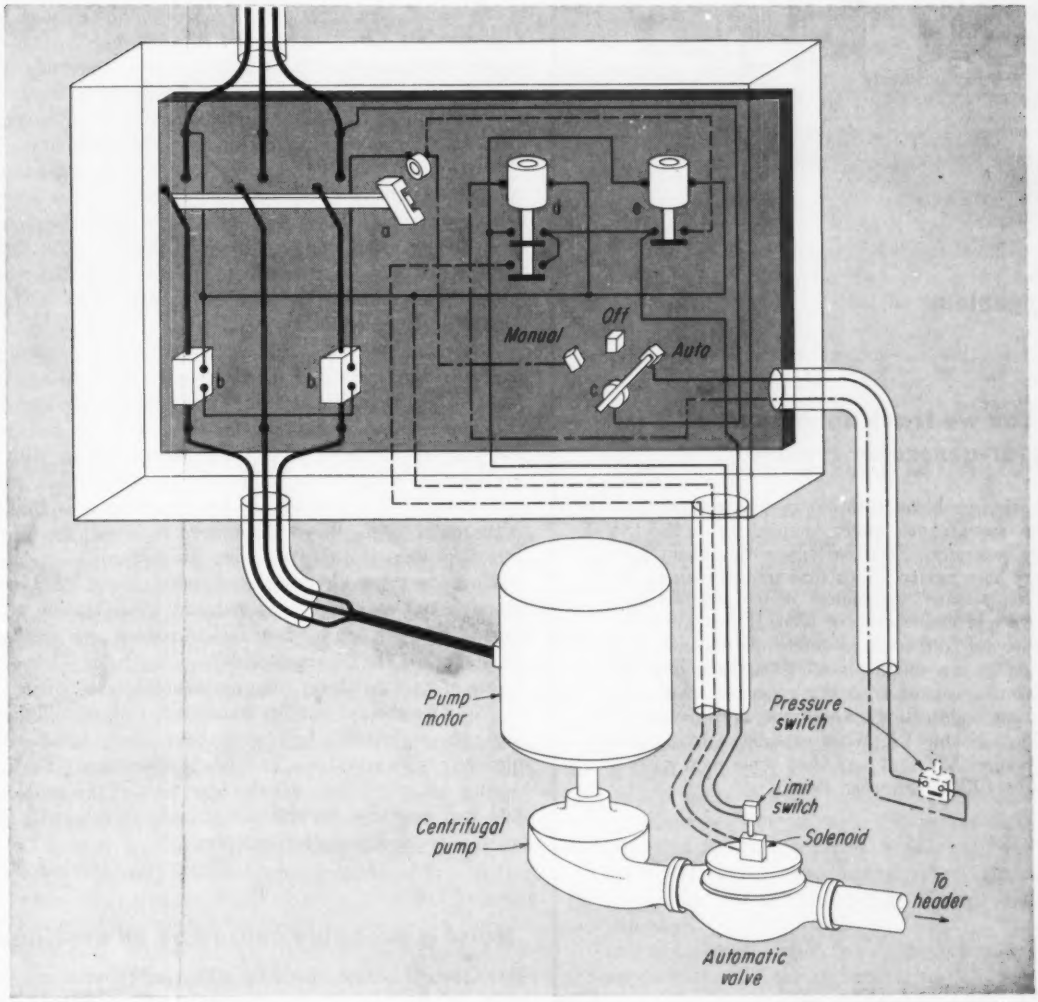
Two antisurge pump-control units

By NORMAN PEACH, Assistant Editor



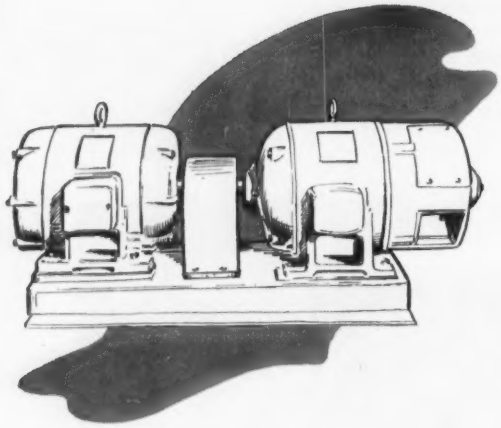
TIME-DELAY RELAYS are used with across-the-line starter. When selector switch is set at *auto*, pressure switch's closing energizes relay *d;* its contacts close after a delay to close contactor *a* and start the motor. Auxiliary contacts of *a* close, and normally closed contacts of *d* open. Decreasing water demand opens pressure switch, de-energizing *d*. Contactor *a* is kept closed by circuit through relay *e* and auxiliary contacts *a*. Time-opening relay *e* is now energized through *d* and auxiliary contacts *a*. After preset interval, *e* opens to de-energize contactor *a*, stopping motor and resetting controls. Adjustment of timing relays allows motors to start and stop in the proper sequence to prevent surges.

Booster pumps feeding into a common header can cause a violent water surge if the pumps come on the line at the same time. Two automatic control hookups designed to prevent such a condition are described below. On left-hand page is a scheme using two timing relays, while the arrangement on the right-hand page is intended for applications where smooth pumping is very important. The latter uses automatic pump-control valves, either globe type or diaphragm-operated by line fluid pressure. A solenoid valve acts as watchdog in piloting the operation.



CONTROL-VALVE CIRCUIT has limit switch and pressure switch. When latter closes, if set for *auto*, relay *d* is energized; its contacts close to energize valve solenoid and relay *e*. Relay *e* closes to energize contactor *a* and start pump. As pump speeds up, valve opens slowly under increasing pressure. In early stages of opening cycle valve-operated limit switch closes to parallel *d* contacts, energizing *e*. Decreasing demand opens pressure switch, de-energizing *d* and solenoid. Valve starts to close but pump runs. Contactor *a* stays closed through *e* and limit switch. As valve shuts, limit switch opens; *e* opens to de-energize contactor *a*, stopping motor. If power fails, the valve automatically shuts.

These plant problems could well be yours...



The problem

How can we track down source of motor-generator trouble?

We're having problems with our m-g set consisting of a 125-hp synchronous motor coupled to a 98.5-kva 180-cycle generator. Five bearings costing about $100 each have been ruined. Each time the set is down for bearing replacement, equipment in the plant is nonproductive and employees are idle. If this keeps up we may have a bottleneck on our hands that will stop production in the entire plant. We have noticed an unusual sound coming from the generator which has been getting louder. How can we track down the source of trouble and stop it? What experience have other POWER readers had that may shed some light on this situation?—*FTR, September* POWER

The solutions

Our m-g trouble was excessive vibration

Too much vibration considerably shortened bearing life on our m-g set. An obvious solution was to have the set balanced in an outside shop. But this would have taken at least one week. So we decided to use a portable vibration analyzer and balancer.

Initial analysis revealed a vibration amplitude varying from 0.0015 to 0.002-in. on both the inboard and outboard bearings at 1200 cpm. At 3600 cpm we measured a discernible vibration on the inboard bearing of the motor. But this vibration amplitude and frequency was instantly erased when the power of the motor was cut off. So vibration at this point probably came from an electrical imbalance which can't be corrected mechanically.

Next, we let the set run under load for about 30 to 45 minutes. A pounding noise developed which grew louder as the set warmed up. An analysis of the entire frequency spectrum revealed an amplitude of 0.0005-in. at 2400 cpm on the generator bearings. A frequency twice the actual rpm indicated that something was loose or misaligned in the revolving system.

This pounding, although of relatively low amplitude, was causing the bulk of the damage to the bearings because of the centrifugal force created by such a mass. This was verified by the fact that these were the bearings that had to be replaced. Further investigation with a stroboscopic lamp brought out the fact that there were several cracks in the welds holding the flanges or spiders to the outer ring. When these were repaired, the vibration amplitude at twice the rpm disappeared.

Vibration caused by rotational imbalance at 1200 cpm, although not excessive, was reduced by balancing to a level of 0.004-in. on all bearings to reduce any unnecessary forces on the repaired welds.

Our m-g set has been running smoothly ever since. If we had sent the set out for balancing, little would have been accomplished. And we'd have been faced with unnecessary expenditures and costly downtime. The imbalance actually found was the least part of the problem. And we were able to find this trouble readily with the aid of a portable vibration analyzer.

J T ROBERTS, *Fanwood, N. J.*

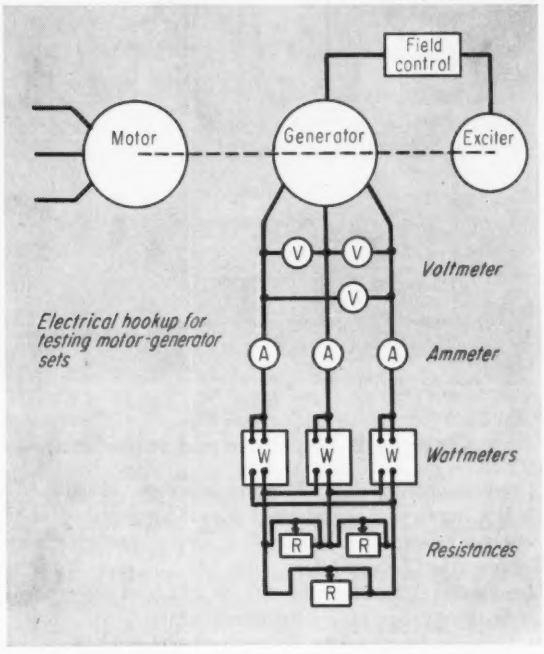
Noise is probably caused by an overload

Three possible causes for *FTR's* bearing failures are (1) faulty lubrication (2) misalignment (3) overload. Unusual sound from generator leads me to suspect an overload. If motor doesn't have proper overload protection and generator has a leak to ground not strong enough to clear itself, this could be cause of the sound.

H R PITONIAK, *Sturbridge, Mass.*

...Here's how Power readers would tackle them

BOB MARKS, Assistant Editor



Electrical hookup for testing motor-generator sets

Careful testing spots trouble sources

FTR's problem sounds like one of vibration and improper electrical loading. A starting point in the search for a remedy is to disconnect motor from generator and see if it runs free and true. Check motor lubricating cups or lines and see if bearings are being oiled properly.

Next, check the motor-generator coupling and see if there are signs of excessive wear at any of the coupling jaws. Also check for excessive misalignment. Replace straight-through couplings with the newer spring type. Run generator and motor together without any load on the generator. Again check bearings of the motor and generator for misalignment. If nothing unusual is noted up to this point, the generator should now be loaded.

FTR doesn't give us the operating voltage of his generator so we can't tell him what resistances to use. But it seems likely that the required resistances will be small.

The generator should be evenly loaded to test the generating effect on the motor. It doesn't make any difference whether it's a wye or a delta hookup. Start the unit and check line currents to see if all phases are within tolerable limits of each other. Next, check line-to-line voltages and see if they are the same. With the same value resistances on all phases, the voltage being drawn should give a visual indication of the electrical wiring condition inside the generator. If vibration occurs at this point, and the line currents do not falter, the motor is probably at fault. It may have a defective coil in which the shorting shows up only under load. If a loud hum is emitted, the windings on the generator or motor are loose. If it's within the generator, there will be a noticeable vibration transmitted back through the coupling. Check this by placing a glass of water on top of both the generator and motor and see which causes the greater action.

If the trouble still has not been found, change one of the external resistances on the generator. Do this to each phase since there may be an electrical imbalance within the generator. This will tend to aggravate it, causing the unit to vibrate and show up a defective phase of the generator.

At this time, it's a good idea to leave the ammeters in the circuit and connect the generator to the plant load. Make sure load condition is typical. Then use a wattmeter on all three phases and check loading on each phase. Calculate the power factor and see what the actual phase relationship is in the plant.

These few suggestions should help *FTR* spot his trouble. But satisfactory results can only be achieved by going through the above procedure very carefully.

P E GARCIA, *Los Angeles, Calif.*

Look for shorted turns in the stator

This problem rings a bell. A few years back we had to repair a motor which made a terrible racket. Bearings were shot and we discovered a short in the field turns. Insulation had burned off when the motor overheated.

I believe *FTR's* m-g set has the same trouble. Shorted turns have probably distorted the magnetic field. And locating this fault isn't an easy job. Fractional-horsepower motors can be checked with a magnetic device called a "growler," but this isn't feasible here.

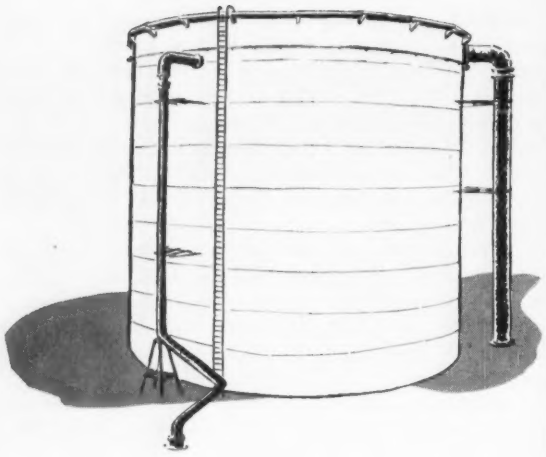
My suggestion is to replace the bearings and operate the m-g set with the generator unexcited and without load. If it turns quietly, look for trouble in the generator. Examine the stator windings carefully. Rotor windings that carry more current would burn out quickly. But in the stator, current through the short circuit is limited by the impedance in series of the remaining intact windings.

Next, disconnect motor from the generator and run the motor alone. If the noise persists the motor probably has shorted turns. In either case, rewind the defective unit. Continued operation with shorted turns in the motor or generator will give abnormal bearing wear.

A M PALMER, *Brooklyn, N. Y.*

Turn page for new problems ▶

More **plant problems**



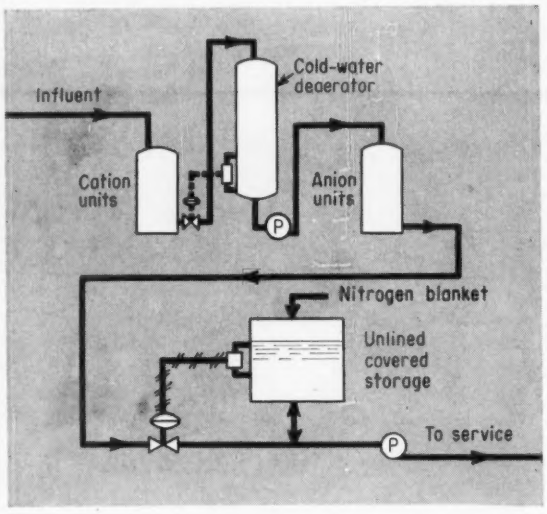
The problem

What tank materials are best for storing demineralized water?

Our plant-expansion plans include installation of a demineralizing plant for process water and boiler feed. Treated-water storage needs haven't been definitely established yet, but it looks as if we can use about 100,000 gal. Effluent of the demineralizing plant will have less than one ppm total dissolved solids at a pH of about eight. What tank materials and linings are best for this service? How do they compare cost-wise? Can we get by with ordinary carbon steel? How about aluminum? I'd like to know what success other readers have had with these various materials of construction.—*SJM, September* POWER

Want some help on plant problems? Send us any of your design and operating headaches. We'll put *Power* readers to work on them

The solutions



Oxygen is big factor in selection

Three essential points of information are missing from *SJM's* inquiry: (1) expected water temperature in the storage vessel (2) dissolved oxygen content of water leaving the demineralizer and (3) distance from the demineralizer outlet to the storage tank and from storage to final end uses of the deionized water.

Demineralized water is aggressive by virtue of its dissolved oxygen content. As water temperature rises this corrosive attack by oxygen is greatly increased. So if heat-exchange equipment is installed between demineralizer outlet and storage, increased temperature almost makes use of a cold-water deaerator mandatory. Even at ambient temperature conditions a deaerator is recommended to avoid corrosion in unlined piping and tanks. This is especially true if pipelines are long.

The cold-water deaerator will remove oxygen in raw water to less than 0.1 ppm and reduce carbon dioxide to less than 5 ppm. This gas removal permits use of unlined steel piping and tankage following the demineralizer when proper precautions are taken.

It's true that the deaerator increases initial investment in the demineralizer plant, but the savings from use of unlined pipe and storage (compared to lined pipe and storage) will pay for the deaerator. If long lines are involved the savings will be many times the cost of the deaerator.

However, even with a deaerator some very conservative engineers still use lined piping and storage following the demineralizer to get the maximum possible protection against corrosion. Some of the more common linings or coatings for storage at temperatures under 130 F include: Class I—Rubber or Saran, $\frac{1}{8}$- to 3/16-in. thick at a cost of about $4 to $5 per sq ft of covered surface; Class II—Hot Bitumastic, Hypalon, Amercoat, etc, using about 6 to 8 coats (6 to 10 mils thick) at a cost of about

$2 to $2.50 per sq ft of covered surface. Aluminum isn't recommended when both corrosion resistance and initial cost are considered.

W C BURNS, *Philadelphia, Pa.*

Consider the use of concrete basins

My experience has been with both metal tanks and concrete storage basins for use as storage or surge tanks for treated water. Concrete basins are by far the most satisfactory and durable. Initial cost of installation is higher, but maintenance is nil. It's also possible to divide the basin to provide economical storage for softened water used for process or service.

R L STOCKDALE, *Cuyahoga Falls, Ohio*

Here's a rundown on comparative costs

Usually piping and exchanger shells in the demineralizing system are lined with rubber or plastic materials. Small fittings for which protective coatings are not easily applied are often made of stainless or monel.

Aerators for carbon-dioxide removal are usually wood with exposed metal parts of stainless steel or monel. Sometimes ceramic materials are employed.

Effluent water piping systems and storage tanks must be capable of resisting corrosion, particularly when a deaerator is not used in the demineralizing system. Piping tanks and other equipment are usually fabricated from carbon steel and protected with a suitable paint or lining such as sprayed rubber. Aluminum construction is suitable as long as the pH is above 7.

Wood storage tanks have the lowest first cost and give satisfactory service. Tanks fabricated of wood need less maintenance, painting and don't corrode. Cypress, fir and redwood are used most frequently. Cypress is highly resistant to rot and doesn't swell or shrink as much as other woods. Approximate cost for these various tank materials are: (1) carbon steel—45c per lb (2) rubber-lined steel—75c per lb (3) stainless steel—$2.50 per lb (4) aluminum—90c per lb (5) wood—25 to 30c per lb.

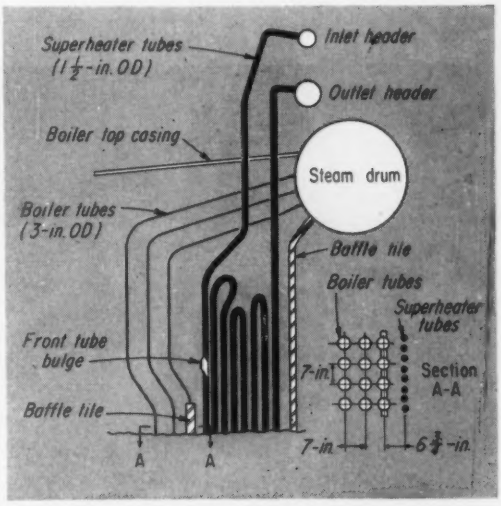
H B WAYNE, *Woodhaven, N. Y.*

Low cost, long life favor use of wood

Why not use a storage tank constructed of 3-in. selected Douglas fir? With an inside diameter of 30 ft and a height of 20 ft, the tank will hold about 100,000 gallons of demineralized water storage. It can be placed on a supporting trestle as high as 40 ft to provide the required head. You will avoid the lining problems of a steel vessel. Upkeep will amount to no more than a few gallons of creosote each year. This tank will last at least 20 years and cost about $10,000 complete.

H R PEARSON, *Kimberly, B. C.*

Your January problems



What caused superheater failure?

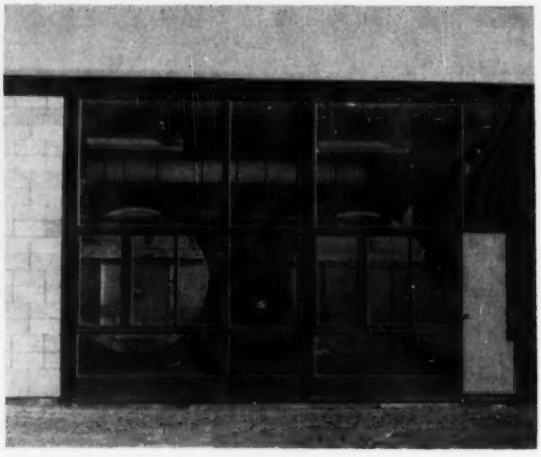
Recently we had superheater failures in two identical 600-psi, 750-F, oil- and gas-fired steam generators supplying steam for process and turbine-generators. Boilers have been in service about four years. Only failure in the first unit was an egg-like bulge with cracks parallel to tube at thinned areas of the bulge. Five superheater tubes in the second unit failed the same way. In each case, bulges appeared on furnace side of the tube within two feet of first baffle as shown above. Inspection of four sectioned tubes showed no metal loss, just general thinning in the bulge. There doesn't seem to be any pattern of failure. Only two of the five failures in the second unit were adjacent in the bank of 36 tubes. Two years ago the superheater tubes were washed to remove a severe accumulation of scale. But inspection failed to show any swelled tubes. What can we do to prevent a recurrence of these failures?—*CCB*

How can we protect cooling tower and piping from freezing damage?

We operate a 400-ton refrigeration plant in a large, sprawling 2-story building. Internal heat load is such that the plant must be run in subfreezing weather. The chilled-water circulating system supplies water to individual air-handling units located throughout the building. What precautions should we take to keep the chilled-water pipe and coils from freezing during shutdown periods at night and over week ends? When internal heat load is low the same problem arises with the condenser-water circuit. Water circulates from machine room in the basement to cooling tower on roof. Pipe shaft is located within the building. What is the best method of protection?—*JF*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches.

Timely practical ideas to help solve



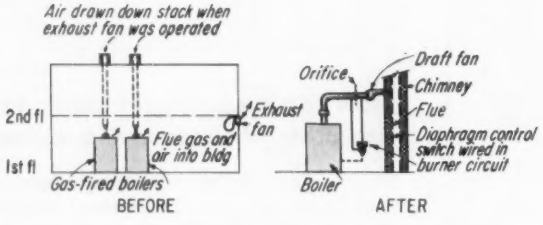
Architect of beautiful new school lets students look into machinery spaces

The power plant of the new John Jay High School, Cross River, N. Y. is no mystery to the students. When architects Ketchum & Sharp designed the group of buildings, they did so with education uppermost in mind.

"Why box the power plant into a mysterious building," they asked. "Since a school is a place of learning, why not have a glass wall on one side of the power plant, thus giving children first-hand information on what goes on inside."

Result is shown in photo, above right. Students can look inside during the course of their daily activities. Seeing the machinery makes them want to learn more about it.

EDITOR'S NOTE: *Why can't this idea be used in more modern buildings? No doubt the public would also take a greater interest in machinery if engine rooms were spotlighted, instead of hidden in a dark hole.*



New i-d fan solves combustion problems

Installation of an exhaust fan in a building created an unsafe and unpleasant condition by robbing two gas-fired boilers of combustion air.

Two chimneys became fresh-air supply intakes. The reversed flow drew combustion products into the building through draft diverters, causing a serious personnel problem with odors and headache complaints.

Installing a small induced-draft fan with a differential pressure controller prevented operation of the burners by opening the control circuit whenever negative pressure or "draft" was not available. The conditions have been OK ever since. The connections can be modified for numerous sequences, sketch.

E F WEHLAGE, *Fairport, N. Y.*

Converting a wood auger

Average drill motor of 2500 rpm is too high for driving a standard screw auger. We convert the standard wood auger that is normally used in a carpenter's brace by grinding off one of the cutting lips. This reduces the cutting speed by one-half. Next, we grind off most of the feed screw tip edge. This gives it a square shape to guide the bit, but won't permit it to draw the bit forward.

Then we cut the tapered square shank down to power drill chuck size by cutting it off at the shoulder.

To avoid hole with rough edges on far side, it pays to take this precaution: Drill through the wood until the feed screw tip emerges. Then reverse direction and finish the hole from far side. Resulting hole is smooth.

PAUL C ZIEMKE, *Clinton, Tenn.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

What caused mysterious air-compressor knocking?

Shortly after I made a transistor detector, a knock developed in one of our 60-cfm air compressors. My homemade detector showed the knock was in the head end of the cylinder.

To check the piston clearances, I removed the discharge-valve units from both the head and crank end. I inserted a length of lead wire through the ports and brought the piston over both the head-end and crank-end dead center to squeeze the wire. That gave me the clearance measurement of piston on each end.

The flattened wire was 0.033 in. on the head end and 0.037-in. on the crank end. That made a liar out of my detector since there could be no bumping unless the lead was flattened down to nothing.

I assembled the compressor and ran it. The knock was still there. My detector again showed it was in the head end. Once more I took leads and again the clearances were the same. I keyed up on every bearing, even removed a 0.006-in. liner on each side of the roller-bearing crankshaft. But the knock didn't go away.

Opening the compressor again, I gave the piston end and cylinder head the old eagle's-eye. I found two shiny spots no larger than pinheads on the inside of the cylinder cover. That was the trouble.

The manufacturer had riveted over the piston rod instead of using a nut against the piston—a common practice. But, in my case, there were two burrs extending about 0.040-in. from the rough riveting job. By smoothing them off with a hand grinder, I put an end to those knocks.

Burrs had been there for 20 years, but I had pulled up on the head bolts a few days before, causing trouble.

R BOETTINGER, *Englewood, N. J.*

Do you know . . .

Plant Operators' Manual shows 12 ways to hook up a pressure regulator for controlling temperature?

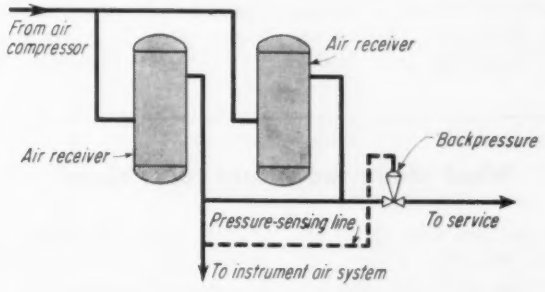
What would you have done?

One morning the oiler of a small plant came in early and started the air compressor, but he didn't turn on the cooling water. A half hour later the compressor was hot and the air sent to the receiver became so hot that it heated up the oil vapor in the receiver. When the oil reached the flash point it exploded.

The safety valve let go, averting a major explosion. But the valves on the air compressor burned out, piping and receiver were ruined and distorted, causing property damage.

I was the boiler inspector and learned that a similar accident had happened before. I suggested installing a thermal-expansion valve on the air line. After that, when the temperature got to an unsafe degree, but before the flash point of the oil was reached, the thermal valve would shut off the compressor so no damage could be done. What would *you* have done?

BILL DAVIS, *Des Plaines, Ill.*



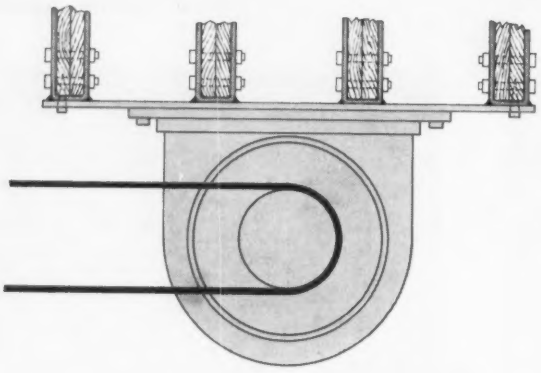
Here's how to save your instrument air

Since instrument-air pressure is important for proper control, be sure to use a protective device in your plant's compressed-air system. As shown in sketch, an automatically controlled backpressure valve installed in the plant's general-service air-supply line gives this protection. If excessive or careless usage of general-service air crops up, the valve closes, diverting all air flow into the instrument-air system. As soon as pressure is recovered, the valve opens and the compressed-air system returns to normal operation.

D W ANTONACCI, *Warrington, Fla.*

Turn page for more Practical Ideas ▶

More **practical ideas**



How to hang motors from wooden joists

Hanging a motor from wood can be a problem. Two joists aren't always enough to support the stresses caused by a heavy motor.

My sketch shows a good clean solution to this stickler. If joists are on thin side, you can stiffen them by reinforcing as shown. Once stiffeners are placed, drill the joist assembly to receive bolts.

U-plates are then formed from flat stock. Careful measurements for bolt holes will give a snug fit of stock around joists. After U's are cut to size, weld them to heavy connecting plate. Make sure weld thickness in corners obeys 45-degree rule. Before assembly is lifted to ceiling, drill small holes for lag screws. Screws will keep rig from falling while the bolts are being positioned.

Tightening up on bolts will minimize bearing load on joists by placing sides of joists in compression. Once assembly is secured to ceiling, motor can be placed. Motor base can be either welded or bolted to flat horizontal plate. If base is not used, make allowance for motor adjustment by some other means.

Bolts used to secure motor right side up should hold OK when motor is inverted. Don't take this for granted, however, but check carefully, especially for heavier motors. When forces are spread over several joists instead of just two, the weight factor becomes more important than forces caused by power transmission.

J E HYLER, *Peoria, Ill.*

What made the safety valve blow?

As soon as the load went up on one of our two watertube boilers, the safety valve blew at 155 psi. We normally carry 150 psi. This didn't happen with the opposite boiler, and it gave us no trouble. As both boilers had been cleaned before the summer season, we were buffaloed.

We assumed the stop valve was defective, so we dismantled it and found two of its piston rings out of round. New rings were installed. But the safety valves again blew when a peak load was reached. So it could not be the old stop valve.

If it wasn't the stop valve (the safety valves were inspected previously), it must be something else. But pinpointing it was a tickler.

We found that 60% of the holes in the steam collector or dry pipe were plugged. When the load went up, the steam couldn't escape fast enough. Then pressure was partly retained in the top drum, causing the safety to blow. To prevent the same trouble occurring in the other watertube boiler, its steam collectors were also cleaned.

J M CURRAN, *Desbiens, Que.*

My biggest boner . . .

I had just been made chief engineer of a small power plant that was on a standby basis. Plant was on the edge of the city's business district. Our 60,000-lb-per-hr boiler was operated at about 5000 lb per hr. It supplied steam to a manufactured-gas plant. We had several headaches, the worst of which was keeping the pulverized-coal fire lit.

I found that by shutting down the forced-draft fan and closing the secondary dampers, we improved the fire. And if we shut down the induced-draft fan, taking in all the air for combustion as primary air, the fire brightened considerably and was much more stable. We ran this way all day and everything was fine and dandy. Combustion was better, coal consumption dropped and furnace puffing stopped. So I gave instructions to continue operating the boiler in this way.

That night when the gas plant shut down we secured the boiler. Next morning the fireman was a little late lighting off the boiler so he started to push the firing. I was breakfasting at home when the manager called. He told me to get to the plant on the double as they were having a great deal of trouble.

As I hastened down the main street I could see soot blowing up the road like a South Dakota duststorm. Right then I knew what was wrong.

We had to assign crews with buckets of soap and water to wash down porches, sidewalks—everything. After a couple of hours of scrubbing I decided that we had better run the induced-draft fan after all.

K M WHITE, *Chamois, Mo.*

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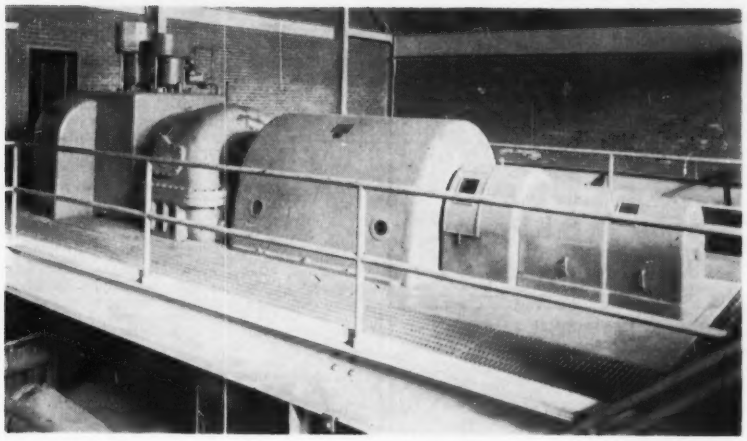

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Auxiliaries
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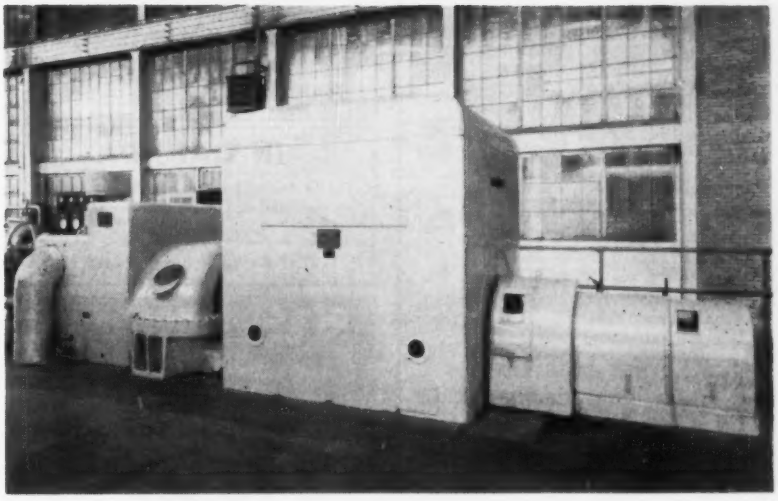

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37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
400	4000/2300	Whse.	720
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
235	4000/2300	G.E. (hoist)	600
200	2300	G.E.	900
200	2300/440	G.E.	720
150	230/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN. MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300/440	G.E.	ATI	720
300	2300/4000	G.E.	TS	720
300	2300/440	G.E.	TS	1200
200	2300/440	Whse.	G	1200
150	440/230	Whse.	G	1200
150	440/230	G.E.	TS	900
125	440/230	Whse.	HR	600

SQUIRREL CAGE MOTORS

500	2300/4000	Elliott	SC	1800
350	2300/4000	G.E.	SEDF	3600
350	2300/440	G.E.	IE-K	1200
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	440/230	G.E.	KT	1800
200	2300	G.E.	KT	1800
200	2300	Cent.	TEFC	3600
200	440/230	G.E.	KT	720
200	2300/440	G.E.	IE-K	1200
150	440	Whse.	X-prf.	3600
150	2300	Al. Chal.	KT	720
150	440/230	G.E.	TEFC	720
150	2300/440	G.E.	AR	1800
150	2300/440		KT	600
150	2300/440	G.E.	FT	1200
125	2300/440	G.E.	K	600
100(2)	4000/2300	L. Allis	OX	1200
100	2300	Cent'l.	TEFC	3600
75(2)	440	Wagner	TEFC	1800

CIRCUIT BREAKERS, 3 Pole

1—6000 Amp., Whse., 600 V., Air, New
1—2000 Amp., R-Smith, 600 V., Air, New
4—1600 Amp., DA-50, Whse., 600 V., Air
6— 600 Amp., R. Smith, 7.5 KV, Sel. oper.
1— 400 Amp., R. Smith, 7.5 KV, outdoor, New

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
200	230	Cr. Wh.	CMC	1250
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	600
60/75	230	G.E.	CD	500/1500

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
125	G.E.	440	Sq. Ca.	250/125
100	G.E.	2300/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	250/125
65	G.E.	2300/460	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph.
3—500 kva, G.E., 13800—2300 V.
3—333 kva, G.E., 2400-240/480 V.
3—333 kva, American, 2400—240/120 V.
3—250 kva, Al. Ch., 13,800—440/480 V.
1—300 kva, Al. Ch., 6900—230 V., 3 ph.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—200 kva, G.E., 13,800—480 V.
3—150 kva, Al. Ch., 2400—230 V.
3—150 kva, Al. Ch., 440-220 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, Whse., 4800/2400-240/480 V., Dry
3—100 kva, G.E., 2400—120/240 V., Pyr.

GASOLINE—ENGINE GENERATOR SETS

2—35 kva, 900 R, 220 V, 3 ph. conn. LeRoi, 6 cyl.
1—31 kva, 1800 rpm, 240/480 V., 3 ph., Ford, 6 cy.

only partial listing

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HARRY J. RICE, Pres.
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MODERN POWER PLANTS

(Will sell complete or separately)

13750 KVA consisting of (11) 1250 KVA Rathbun Jones NATURAL GAS ENGINE GENERATORS 3/60/2400-4160V. with Switchgear.

1875 KVA TURBINE—400 PSI 700°F. Condensing, 2300 V. GENERATOR, 25000#/hr. 450 PSI BOILER; include all auxiliaries, & 25 TON CRANE.

2500 KVA TURBINE 600 PSI, Extracting 160 PSI, B.P. 30 PSI; 480 V. GENERATOR; 75000#/hr. 650 PSI Oil fired BOILER with complete accessories.

NEW BOILERS

122,500#/hr. 565 PSI @ 850°F.
44,500#/hr. 450 PSI @ 735°F.
35,000#/hr. 285 PSI @ 577°F.

Complete units including Superheaters, Economizers, Fuel Oil Burners, Soot Blowers, valves and fittings.

OTHER HIGHLIGHTS

540 KW—TURBO GENERATOR, 200 PSI 120/240 V. D.C.
200 HP—BOILERS, 160#—Stoker
175 HP C.E. Pkg BOILER, 275# Oil
6000 KVA—TRANSFORMER OISC 44000/4160 Volt
500 KVA—TRANSFORMERS, OISC (6), 66000/480 Volt
D-17000 Cat. Diesel POWER UNIT.

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POWER EQUIPMENT DIVISION
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310 THOMPSON BLDG. TULSA 3, OKLAHOMA Diamond 3-4890

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Three (3) — 1000 KVA — GE — Type H, Form VDM, Single Phase, 60 cycle, 13,200 V Pri. W 4—2½% taps below, 2300/4000 y sec. Ser # over 7 million.

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Philadelphia 37, Pa. • CU 9-4910

FOR SALE DeLAVAL BOILER FEED PUMP

Size LC-315J Turbine & Pump 4650 RPM—540 PSI Steam 15 PSI Back Pressure—Pump 675 GPM at 725 PSI—New, Unused, with spare parts. Sacrifice Price.

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280 Ton Twin York AMMONIA COMPRESSOR (140 ton each)

8 Cylinder, Driven by De Laval turbine, 400 H.P., 140 lb. steam—30 lb back pressure, 4540 RPM, thru double shaft helical reduction gears 720 RPM. NEW 1951.

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EMPLOYMENT OPPORTUNITIES

(Continued from page 182)

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POSITIONS VACANT

Wanted—University graduate Engineer with at least five years experience operation steam electric generating station for responsible position in Maracaibo, Venezuela. Preference will be given Spanish speaking applicant. Salary dependent on qualifications. P-8319, Power.

Director of Utilities—City of 27,000 in Eastern North Carolina Steam generation plus purchase power. Under City Manager has charge of Electric-water—Sanitary and Storm Sewer systems. Graduate Engineer or equivalent with at least 10 years experience in Municipal affairs. Want complete resume and salary expected. Superintendent of Power Plant—Modern coal burning plant. Graduate Engineer or equivalent experience. Address: City Manager, Kinston, North Carolina.

Power Engineer for new power unit. Expanding Middle-Atlantic States paper mill has an opportunity for top-flight engineer with minimum of four years' experience including some turbo-generator. Send resume. P-9497, Power.

Executive Engineer — Necessary education and background to assume full responsibility for plant operation, air conditioning, refrigeration, high pressure steam and maintenance of a hospital. Engineering degree and 10 years' experience preferred. Licensed. Hospitalization, vacation sick time and pension plan available. Please submit resume of experience to P-9552, Power.

SELLING OPPORTUNITY OFFERED

Wanted — Manufacturer's Agents to sell line of combustion and process controls and instruments. Choice territories available. RW-8864, Power.

POSITIONS WANTED

Grad. M.E. Reg.—Age 36, 15 yrs. exp. all phases marine and stationary steam power work. Supervisory position desired. PW-9233, Power.

Plant Engineer—Operation, Maintenance and Repair—Age 36, Married, 11 years operation, 3 years maintenance and repair, in all phases of the modern steam plant. Capable of accepting plant superintendentship or will consider your offer. PW-9486, Power.

Plant Electrical Engineer, age 48, extensive electrical engineering and maintenance background in steel mill metal fabricating and related industries. Well educated, possesses initiative, common sense and energetic personality tempered with matured management experience. Will relocate with a sound and progressive organization in a functional responsibility position leading to mutual advantage. PW-9532, Power.

Chief Engineer, age 38, technical education, 14 years experience in the operation, maintenance, construction, and plant betterment of turbo-electric power plants. PW-9551, Power.

CONTRACT WORK WANTED

Wanted by Established Sales Office In Chicago Trade Area Accounts in Steam Power Field. Interested in Coal and Ash Handling Equipment, Fire Tube Packaged Boilers or Related Products. Contact CWW-9473, Power.

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WAREHOUSE DIVISION

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99′	3″	Sch	80 — Gr P1
400′	4″	Sch	40 — Gr P1
200′	4″	Sch	80 — Gr P1
25′	6″	Sch	40 — Gr P1
180′	8″	Sch	40 — Gr P1
23′	8″	Sch	30 — Gr P1
422′	3″	Sch	160 — Gr P2
51′	4″	Sch	120 — Gr P2
110′	6″	Sch	40 — Gr P2
67′	8″	Sch	40 — Gr P2
22′	10″	Sch	100 — Gr P2
20′	16″	Sch	100 — Gr P2
68′	2½″	Sch	40 — Gr P5
140′	2½″	Sch	80 — Gr P5
87′	3″	Sch	40 — Gr P5
200′	3″	Sch	80 — Gr P5
200′	4″	Sch	40 — Gr P5
160′	4″	Sch	80 — Gr P5
33′	6″	Sch	40 — Gr P5
25′	6″	Dble Ex Hy	— Gr P5
17′	6″	Sch	160 — Gr P5
110′	8″	Sch	40 — Gr P5
113′	8″	Sch	80 — Gr P5
12′	8″	Sch	160 — Gr P5
187′	10″	Sch	60 — Gr P5
300′	2½″	Sch	80 — Gr P11
550′	4″	Sch	40 — Gr P11
460′	3″	Sch	80 — Gr P11
340′	3″	Sch	160 — Gr P11
83′	4″	Sch	40 — Gr P11
600′	4″	Sch	80 — Gr P11
120′	4″	Sch	160 — Gr P11
47′	4″	Dble Ex Hy	— Gr P11
23′	8″	Sch	160 — Gr P11
70′	6″	Sch	40 — Gr P11
440′	6″	Sch	80 — Gr P11
1800′	6″	Sch	160 — Gr P11
50′	6″	Dble Ex Hy	— Gr P11
300′	8″	Sch	40 — Gr P11
1070′	8″	Sch	80 — Gr P11
1248′	8″	Sch	160 — Gr P11
41′	8″ x 1.264″ Nom. Wall		— Gr P11
25′	8″ x 1.25″ Nom. Wall		— Gr P11
1080′	10″	Sch	60 — Gr P11
1076′	10″	Sch	80 — Gr P11
28′	10″	Sch	120 — Gr P11
53′	10″	Sch	160 — Gr P11
53′	10″ x 1.363″ Nom. Wall		— Gr P11
95′	12″	Sch	80 — Gr P11
95′	12″	Sch	100 — Gr P11
24′	12″	Sch	120 — Gr P11
324′	14″	Sch	80 — Gr P11
22′	14″ x 1-13/16″ Nom. Wall		— Gr P11
170′	16″	Sch	80 — Gr P11
32′	16″	Sch	100 — Gr P11
17′	24″ x ¼″ Nom. Wall		— Gr P11
98′	3″	Sch	160 — Gr P12
20′	5″	Sch	40 — Gr P12
180′	5″	Sch	160 — Gr P12
37′	6″	Sch	80 — Gr P12
31′	8″	Sch	100 — Gr P12
45′	8″	Sch	20 — Gr P12
22′	8″	Sch	40 — Gr P12
54′	10″ x 7/16″ Nom. Wall		— Gr P12
33′	24″	Sch	40 — Gr P12
225′	3″	Sch	80 — Gr P22
780′	4″	Sch	40 — Gr P22
88′	4″	Sch	80 — Gr P22
80′	6″	Sch	80 — Gr P22
48′	6″ x 1.10″ Nom. Wall		— Gr P22
330′	8″	Sch	80 — Gr P22
12′	8″ x 1.312″ Nom. Wall		— Gr P22

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OUR 52nd YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
700	Whse.	Slipring	2300/4000	1200
600	Elliott (2)	Sq. Cage	2300	900
500	G.E.	Slipring	2300	900
500	Allis Ch.	Slipring	2300/440	600
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2300	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E.	Slipring	2300	514
350	Br. Boveri b.b.	Sq. Cage	4800/480	720
350	G.E.	Sq. Cage	2200	1800
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
350	G.E.	Slipring	220/440	900
300	G.E.	Slipring	2200/440	600
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Slipring	2300	514
300	Whse.	Synch.	440	1200
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Sq. Cage	2200	1800
250	Whse.	Sq. Cage	2300/440	600
200	G.E.	Slipring	440	600
200	L.A. TEFC	Sq. Cage	440	1200
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Whse.	Sq. Cage	2200/440	900
150	Rel TEFC	Sq. Cage	220/440	900
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E. (2)	Sq. Cage	2200.440	1800
150	Whse.	Slipring	220/440	1200
150	G.E.	Sq. Cage	2300	900
125	El. Machy. (2)	Synch.	220/440	400
125	G.E. T.E.F.C.	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
100	Smith b.b. (6)	Sq. Cage	220/440	1800
75	G.E. b.b. (8)	Sq. Cage	220/440	1200

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	Gen. Elec.	RC	250	1450
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
100	Cr. Wh.	CCD-65H	125	1200
75	Gen. Elec.	CD-123	125/250	1200
75	Whse. b.b.	SK-123L	250	1800
60	Ideal	D	125	1150
60	Reliance b.b.	262-T	250	1200
40	Reliance b.b.	230-T	250	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
250	Cr. Wh.	101-H	230	1150
200	G.E. (2)	RC-38	230	1150
200	Whse. b.b.	SK	250	287/575
150	Whse.	SK-184	230	850
150	Whse.	SK-210	230	320/1000
150	G.E. b.b. dyn.	TLC-50	250	1750/3500
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Whse. (4)	SK-163	230	500/1500
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-314	230	1150/1750
50	G.E.	BF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
40	Whse. b.b. (2)	SK-163	230	300/1200
25	Whse. (2)	SK-153	230	300/1200

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
300	Whse. (2)	2200/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	Gen. Elec.	220/440 AC	250 DC
75	Star b.b.	220/440 AC	250 DC
75	G.E.	200/440 AC	125 DC
60	Allis Ch.	220/440 AC	250 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC
40	Ideal	220/440 AC	250 DC

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MO nroe 6-7409
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MOTORS — DC
230 Volt Variable Speed

H.P.	Make	Type	Speed
115	West.	SK-190	600/1200
100/125	Rel.	1050T	500/1500
75/100	Cr. Wh.		500/1500
75	Rel.	T1050T	300/1200

MOTORS—DC
500 Volts

H.P.	Make	Type	Speed
3300	West.	Mill	140/210
2250	West.		90/210
1500	West.	T.E.	600
600	Al. Chal.		300/600
150	West.	Mill	360/1200

NEW
100 KW DIESEL SETS
100 kw, 120/240 Volts DC Delco Generator driven by 152 H.P. 1200 rpm 8 cylinder Model GDB-8 Superior Diesel Engine.

SLIP RING MOTORS
3 ph—60 cy—220 or 440 Volts (*2300 Volts or higher)

H.P.	Make	Type	Speed
3500	*G.E.	MT-30	240
2500	Al. Chal.		300
1500	*West.	HF-1227	252
1500	*G.E.	MT-16	443
1000	*G.E.	MT-575S	1185
500	*Al. Chal.		293
300	*West.	CW	1150

AC MOTORS
3 ph—60 cy—220 or 440 Volts 2300 Volts or higher

H.P.	Make	Type	Speed
4000 new	*West.	Syn.	1200
2000	*Ideal	Tot. enc.	900
1500 new	*West.	Syn.	450
920 new	G.E.	Syn.	300
800	*G.E.	K-6346SY	1770
800	*West.	C84-34C15	1770
500	*West.	Syn.	1800

MOTOR-GENERATOR SETS
3500 KW, 514 RPM, 350/700 VDC, 13800/6900/4160 VAC, Allis-Chalmers (2)
1250 KW, 450 RPM, 250 VDC, 2300/4160 VAC
200 KW, 1200 RPM, 250 VDC 2300/4000 VAC, Westinghouse Generator

TRANSFORMERS
2500 KVA, 13800 Pri. 2300 Sec. 3/60 General Electric
1500 KVA, 24000 Pri. 480 Sec. 1/60 Westinghouse, SL, OISC, ...(6)

MAGNETIC CIRCUIT BREAKERS
6000 Amp G.E. 3 Pole AL-2-100
4000 Amp G.E. 2 Pole AL-2-50
3000 Amp G.E. 3 Pole AK-1-75
1600 Amp G.E. 3 Pole AK-1-50
1200 Amp West 3 Pole DH-150

WESTINGHOUSE FREQUENCY CHANGER
1250 KVA, 800 Volt, 1 Phase, 960 Cycle, 1800 RPM Generator driven by a 1875 HP., 2300 Volt, 3 Phase, 60 Cycle Syn. Motor. Modern water-cooled set, complete with Controls, Furnaces, (2) Exciters, mounted on steel base.

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SQUIRREL CAGE MOTORS
NEW AND GUARANTEED REBUILT

HP	Make	Type	Speed
500	L.A. B.B. Splash. 440 Volt	FX-1468	3600
400	West. B.B. Drip.	CSP-5815	1800
400	L.A. B.B. Splash.		1800
400	West. S.B. Open	CS	900
400	West. S.B. Splash 2300 Volt	CS-398	720
300	G.E. S.B. Open	IK	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open	CS-1002	600
250	G.E. S.B. Open	KT	1800
250	L.A. B.B. Drip.	OGX-117	1800
250	G.E. S.B. Open 2200 v	IK-16	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. B.B. Drip	K-6325	1800
200	Cont. T.E.F.C.B.B.	NP-686C	1800
200	L.A. B.B. Open	OS-116	1800
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-15S	1200
200	G.E. S.B. Open 2200V	IK	1200
200	L.A. B.B. Drip.		1200
200	G.E. S.B. Open	IK	900
150	West. TEFCBB XP	CS-779.6	3600
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	Wst. S.S.B.Opn	CS-761C	1800
150	G.E. TEBB	K	1800
150	West. S.B. Open 2200V	CS	1800
150	G.E. S.B. Open	IK	1800
150	West. B.B. Open	CS-771C	1800
150	Marathon. B.B. Drip	TDA-584	1800
150	G.E. B.B. Open	KT	1200
150	Cont. T.E.F.C. B.B. New		900
150	G.E. S.B. Open	KT-558	900
150	G.E. S.B. Open	IK	720
125	G.E. TEFCBB	K	3600
125	A.C. B.B. Open	ARX-505	3600
125	West. S.S.B. Open New	CS-607	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open	CS	1800
125	El. Dyn. B.B. Drip.	KNX-22	1800
125	G.E. S.B. Open	KT-553	1200
125	G.E. S.B. Open	IK	1200
125	G.E. S.B. Open	IK	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
125	West. B.B. Open	CS-874C	600
100	Howell T.E.F.C.B.B.	K-505	3600
100	G.E. B.B. Drip	K-504	3600
100	G.E. S.B. Open	KT-343	1800
100	G.E.-B.B. Open.	K-504	1800
100	El. Dyn. T.E.F.C.B.B. XP	KNX-223	1800
100	L.A. T.E.F.C.B.B.	JX-113	1800
100	G.E. S.B. Open	KT-347	1200
100	West. SSB Open	CS-607	1200
100	West. S.S.B. Splash.	CS-770.8	1200
100	Wagner T.E.F.C.B.B.	CP-635	1200
100	Reliance B.B. Drip.	AA-5084	1200
100	G.E. S.B. Open	KT-356	900

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278 CFM 125 psi 8⅝-4⅝x5 Chic. Pn. PB
311 CFM 1500 psi 10½-7⅛-3⅛x13 Ing. ES3
465 CFM 100 psi 12x11 Ing.
502 CFM 125 psi 12x13 Worth. H.B.
528 CFM 100 psi 14x12 Ing ER
585 CFM 100 psi 15-9¼x12 Ing. XRE 3-60-4160
628 CFM 100 psi 14x13 Ing ES
676 CFM 100 psi 15-9¼x12 Ing. XRB
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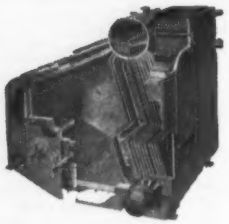

# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

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2—50, 6—37½ KVA, G.E. 1/60/2400-120/240 OISC.
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H.P.	MAKE	TYPE	SPEED
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600	West.	CS	720
600	*G.E.	K-63455	1200
500	*G.E.	K-63455	1200
500	*G.E.	I-13-E	900
350	*G.E.	KT-559-A	1800
300	*G.E.	K6344	1200
250	*W (TE)	CS-81203	1800
250	*G.E.	KT-509-S	1800
250	*West.	CS-875-S	1800
250	Brook	RS28	1200
200	*G.E.	FT-549	3600
200	*G.E.	I-K-13B	1800
200	West.	CSP-581-S	1800
200	Brook	RS-27	1200
200	*West.	CS-930-A	900
200	G.E.	KT-564-S	720
200	*Al.-Ch.	AN-37-G	720
200	*West.	CS-1010	600
200	Al.-Ch.	ARW-631	600
150	Cr-Wh	SC-140	3600
150	Al.-Ch.	AN 30-F	1200
150	West.	CSP-5815	1200

M.G. SETS

Kilowatt	Make	Volts AC	Volts DC
1000	West.	4000	250
750	G.E.	4160	275
500	West.	440	250
400	Al. Ch.	2300	240
300	West.	2300	250
200	G.E.	2300	275
200	Rdgwy	2300	250
150	Al. Ch.	2300	250
150	West.	2300	250
125	Cr. Wh.	4160	125
125	G.E.	2300	250
100	G.E.	2300	250
100	Al. Ch.	2300	60
60	G.E.	220/440	250
40	G.E.	220/440	250

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H.P.	MAKE	TYPE	SPEED
2500	*G.E.	MT (Mill Type)	257
1100	*G.E.	MT	720
1000	G.E.	M-575-S	1200
1000	*West.	CW	450
600	*G.E.	M-6345-S	1800
500	G.E.	M-6345	1200
400	*G.E.	MTP-565	1200
350	*Al.-Ch.	ARYW	1800
300	Cr-Wh	SR-70-R	1800
250	Al.-Ch.	ARY-626	1800
250	*G.E.	I-M-17A	720
200	G.E.	I-M-16	600
200	*West.	CW1950A	514
150	Cr-Wh	SR-50R	1800
150	G.E.	I-M-15A	600
125	G.E.	I-M-15A	600
100	G.E.	I-E-13A	1800
100	G.E.	MT558	720
100	G.E.	I-M-15A	425
75	West.	CW-770	1200

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Qu	KV	Make	Type	Phase	Voltages
2	3000	Moloney	TCR	3	7200/6600-4160/2400
2	750	G.E.	K	1	4600-120/240
1	750	Niagara	Air Cooled	3	2400/4160-480/277
1	300	Penna.	(Askarel)	3	12470Y/7200-240
2	250	G.E.	H Pyranol	1	4800/3820Y/120/240
2	250	West.		1	2300/4600-230/460
3	200	G.E.	HS	1	2400/4160-240/480
3	200	G.E.	H	1	7800-15600-220/440
1	150	Eisler	OA	1	4160-240/480
3	100	G.E.	H		2400/4160-240/480
1	50	G.E.	Air Cooled	1	440/220-220/110
3	50	G.E.	HS	1	2400/4160-240/120
1	50	Amer.	Abestol	3	4160-120/208Y
5	50	G.E.	HS	1	2400/4160-240/480
4	25	West.	Hypersil	1	2400/4160-120/240

MOTOR GENERATOR SETS

Qu.	KW	Make	Speed	DC	AC
3	60	E.M.	1200	125	220 v. Syn.
1	75	G.E.	1200	125	2300/4160 Syn.
2	100	West.	1200	250	2300/4160Y Syn.
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y SR
1	300	G.E.	1200	250	440 Syn.
1	1000	West.	720	600	2300/4160Y

ENGINE GENERATOR SETS

1—Hercules Gas HXE 62.5 KVA Westghe 3/60/480—1200
1—Wisconsin Gas (Air) PE-99 7.5 KVA Master 1 or 3/120—2200 r.p.m. NEW.

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	690	CW	220/440
1	60	G.E.	1800	MT	220
1	75	G.E.	600	IM	440
1	100	West.	1800	T.E.F.C. B.B.	220
3	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	450	MT	2200
1	500	G.E.	1200	M569Z	2300/4160Y

D.C. MOTORS—230 VOLTS

Qu	HP	Make	Speed	Type
1	75	Star	1200	SR 60 L B.B.
1	92	West.	425/1000	173 FR
1	350	G.E.	1200	Padestal

SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—275 HP, 1180 RPM G.E. Type KT 559RS 2200V
2—200 HP, 1790 RPM, G.E. Elec. KF, TEFC, 2300V
1— 40 HP, 1750 RPM Wagner 444 440V T.E.F.C.
1— 25 HP, 1170 Howell 405 440V T.E.F.C.

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125 HP 600 RPM G.E. Type TS 2200 V.
125 HP 900 RPM G.E. Type TS 4800 V.
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A. C. MOTORS—3 ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT-6	6600	1187
1	800	Whse.	CW	550	1776
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-15	440	1775
1	500	G.E.	MT-412	2200	450
1	500	Whse.	CW	550	514
1	350	Cr. Wh.	SIZE-718R	203/406	1763
1	350	G.E.	IM-17A	440/2200	720
1	350	Whse.	CW-1039C	440	720
1	250	G.E.	MT-424Y	4000	257
1	250	Cr. Wh.	SIZE-290	2300	350
1	250	A.C.		550	600
1	250	G.E.	MT-563Y	440	875
1	250	Whse.	CW-1010	2200	435
1	200	Whse.	CW-874D	220	885
1	200	G.E.	IE-13B	220	1760
1	200	G.E.	IM	2200	880
2	200	G.E.	IM	2200	435
2	200	Whse.	CW-890	2300	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-539AY	2300	3600
1	550	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
3	500	G.E.	KF	2300	3600
2	450	Whse.	CS-1420	2300/4150	354
2	400	Whse.	CS-7151-610H	6600/4000	3585
1	400	G.E.	LK	2200	500
1	300	Whse.	CS-1002	2300	600
1	200	Whse.	CS-963H	2300	1175/878
1	200	G.E.	KT-557	440	1800
2	200	Whse.	CS-855S	220/440	1758
1	150	G.E.	CS	440	530

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-8L	13800/6900	514
1	3500	G.E.	TS-8438P	2300/4000	360
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/4600
1	2000	G.E.	514	600	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	600	600	2300/4150
1	1000	G.E.	900	260	6600
1	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	500	Whse.	900	125/250	440
1	350	G.E.	900	125	440/2300/4160
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El. Mhy	1200	250	2300/4150
1	300	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/2300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300
1	100	G.E.	1200	250	4160/2400

TURBO GENERATORS

Qu.	KW	Make	Data
1	300	G.E.	175/200# Cond. 480/2300 V.
1	1000	G.E.	150# no Cond 2400 V.
1	4000	G.E.	400# surface condenser 2400/4150 volts.

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
3	3333	Whse.	OISC	1	13800x2300
3	1666	G.E.	OISC	1	13800x460
2	750	G.E.	FUR	1	4800x265/55
3	500	KUHL	OISC	1	13800x6600
1	225	Marcus	Air	3	auto 208/220
3	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
3	6750	G.E.	60/25/60	13200/13200
1	5000	G.E.	60/50/60	11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

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1—1375 H.P. G.E. MCF, 415 V. 1200 RPM D.C. motor with 1100 KW G.E. MG Set 415 V DC, 2300/4000 V. 720 RPM 3 ph. 60 cycle.
1—1200 HP G.E. MPC, 600 V. D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 KP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

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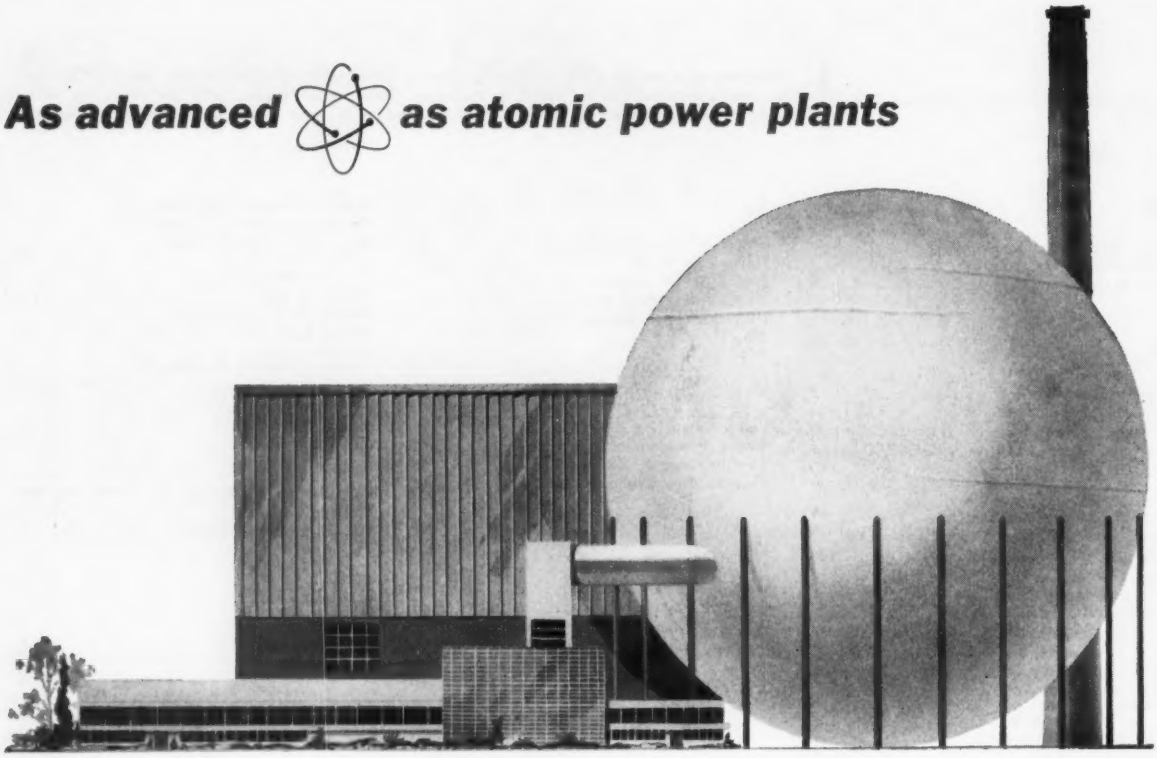
As advanced as atomic power plants



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50 GPM PER SQUARE FOOT

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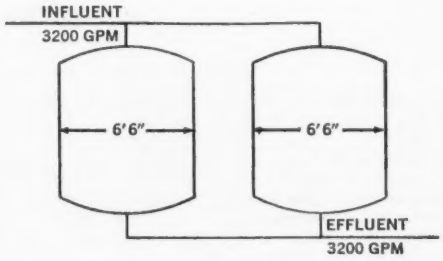

Infilco Inc., General Offices: Tucson, Arizona, P.O. Box 5033
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INFILCO

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Industry Standard for Lower Maintenance Costs

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THE ONE *Great* NAME IN VALVES

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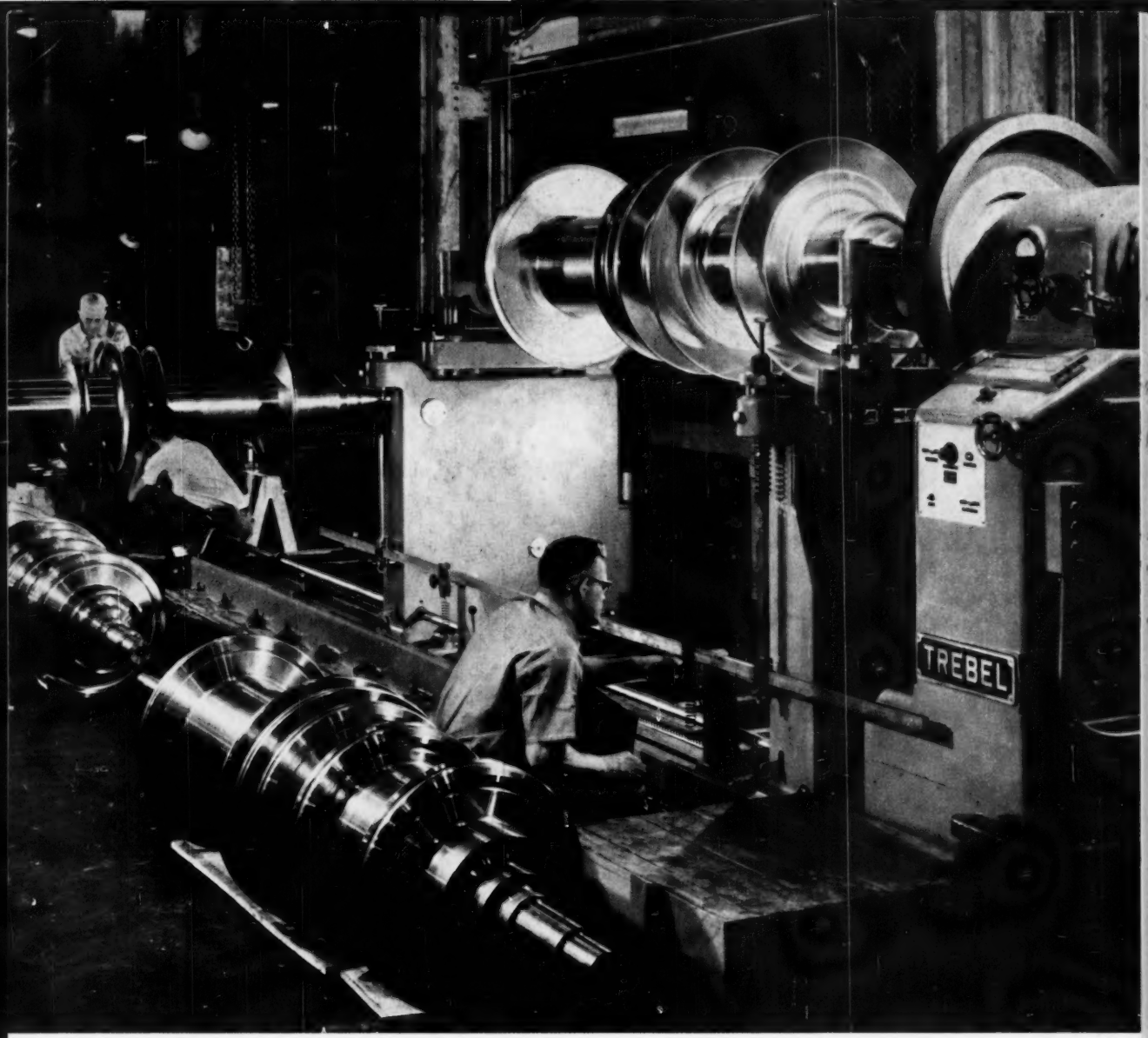

Balancing rotor for a 6,000 hp Worthington high-speed turbine.

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Long, trouble-free life of Worthington high-speed turbines stems from two primary sources: One: the multiple achievements of Worthington engineers. Two: the wide variety of tests to which machines are subjected before shipment to customer. Worthington, for example, is the only manufacturer that load-tests all multi-stage turbines. In this process, the turbine is coupled to a water brake so that its precise behavior under actual performance conditions can be predicted. Only when the turbine has passed this – and many other exacting tests – is it approved for shipment. This infinite attention to detail, this painstaking insistence upon perfection, explains why Worthington is today the nation's undisputed leader in high-speed turbine installations. Worthington Corporation, Harrison, New Jersey. 48-3

WORTHINGTON

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